INSTRUCTION BOOK

for

51R-2 VHF NAVIGATION RECEIVER

COLLINS

Manufactured By

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

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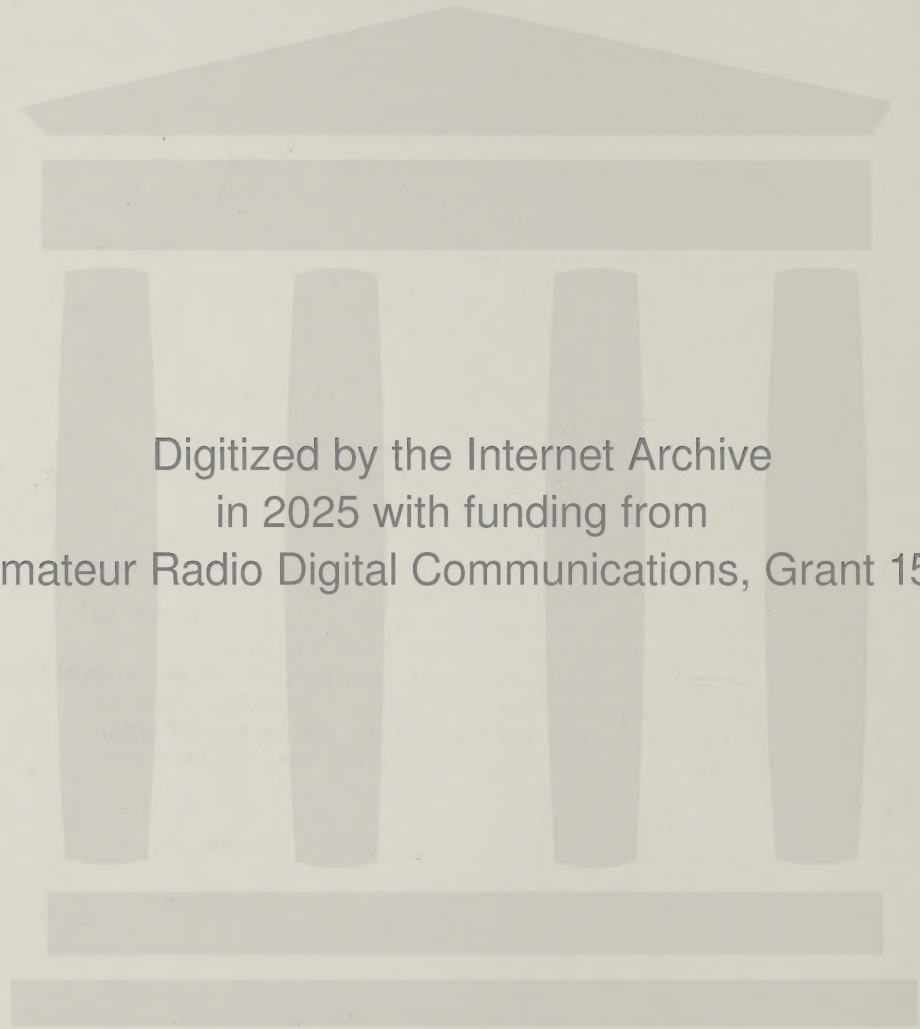

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GUARANTEE

The equipment described herein is sold under the following guarantee:

Collins agrees to repair or replace, without charge, any equipment, parts or accessories which are defective as to design, workmanship or material, and which are returned to Collins at its factory in Cedar Rapids, Iowa, transportation prepaid, provided that the foregoing shall not be applicable to

(a) Equipment or accessories as to which notice of the claimed defect is not given Collins within one year from date of delivery;

(b) Equipment and accessories manufactured by others than Collins, tubes and batteries, all of which are subject only to such adjustment as Collins may obtain from supplier thereof;

(c) Equipment or accessories which shall fail to operate in a normal or proper manner due to exposure to excessive moisture in the atmosphere or otherwise after delivery, any such failure not being deemed a defect within the meaning of the foregoing provisions.

Collins further guarantees that any radio transmitter described herein will deliver full radio frequency power output at the antenna lead when connected to a suitable load, but such guarantee shall not be construed as a guarantee of any definite coverage or range of said apparatus.

The guarantee of these paragraphs is void if equipment is altered or repaired by others than Collins.

Notice of any claimed defect must be given to Collins prior to return of any item. Such notice must give full information as to nature of defect and identification (including part number if possible) of part considered defective. Upon receipt of such notice, Collins will promptly advise respecting return of equipment. Failure to secure our advice prior to the forwarding of goods for return may cause unnecessary delay in the handling of such merchandise.

No other warranties, expressed or implied, shall be applicable to said equipment, and the foregoing shall constitute the Buyer's sole right and remedy under the agreements in this paragraph contained. In no event shall Collins have any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any cause.

HOW TO ORDER REPLACEMENT PARTS

When ordering replacement parts, you should direct your order as indicated below and furnish the following information in so far as applicable:

Address: Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

Information Needed:

(A) Quantity required
(B) Part number of item
(C) Item number (obtain from Parts List or Schematic Diagram)
(D) Type number of unit
(E) Serial number of unit
(F) Serial number of equipment

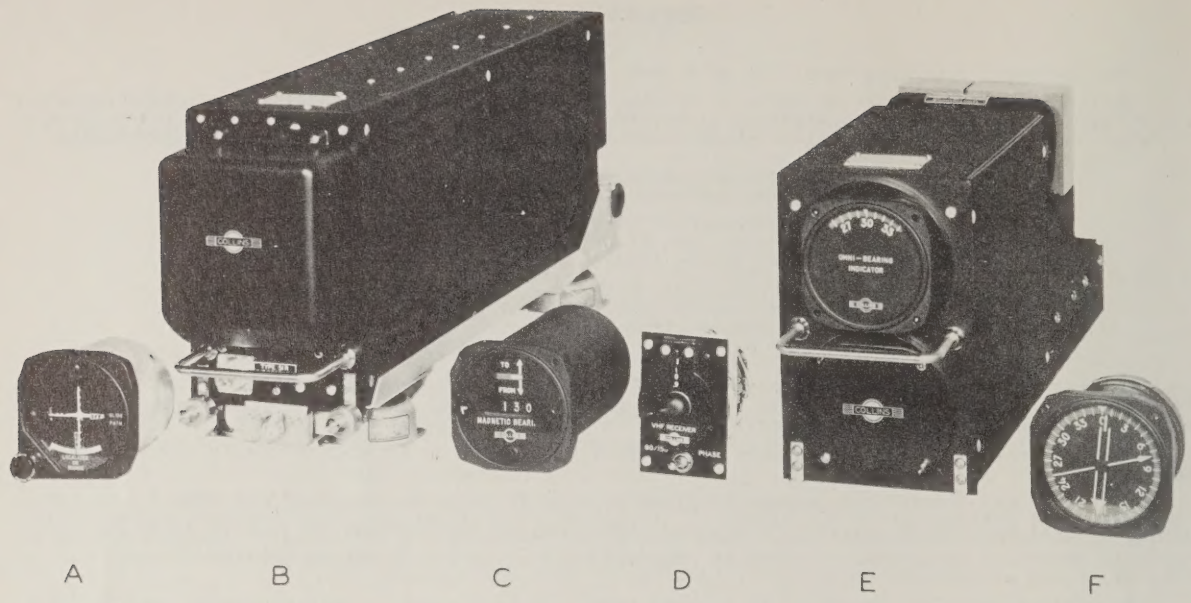
HOW TO RETURN MATERIAL OR EQUIPMENT

If, for any reason, you should wish to return material or equipment, whether under the guarantee or otherwise, you should notify us, giving full particulars including the details listed below, in so far as applicable. Upon receipt of such notice, Collins will promptly advise you respecting the return. Failure to secure our advice prior to the forwarding of the goods or failure to provide full particulars may cause unnecessary delay in handling of your returned merchandise.

Address: Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

Information Needed:

(A) Date of delivery of equipment
(B) Date placed in service
(C) Number of hours in service
(D) Part number of item
(E) Item number (obtain from Parts List or Schematic Diagram)
(F) Type number of unit from which part is removed
(G) Serial number of unit
(H) Serial number of the complete equipment
(I) Nature of failure
(J) Cause of failure
(K) Remarks



A B C D E F

A. Deviation Indicator - Weston 888 Type 3
Collins 458 0126 00

B. 51R-2 Receiver on Shockmount

C. 336A-1 or A-2 Radial Selector

D. 314U-1 or U-5 Control Box

E. 351A-1 Accessory Unit (provides mounting for 2 337A-1 or A-2 Radial Converter Indicators and 3 333B Servo Amp. for R.M.I. and 2 416N-1 Power Units for 2 51R's)

F. 332C-1 Radio Magnetic Indicator

Photo shows 1 337A-1 and 416N-1 unit mounted on 351A-1 Accessory Unit.

COLLINS VHF NAVIGATION EQUIPMENT

INTRODUCTION TO THE OMNIDIRECTIONAL RADIO RANGE SYSTEM

The Omnidirectional Radio Range now being installed on a national basis by the CAA is intended to first supplement and later supplant the low frequency radio range now in use on the United States airways system. The omnidirectional radio range, sometimes called ODR and officially referred to by the CAA as VOR (Visual Omni-Range), operates at VHF, and hence is free from static interference which is a frequent source of difficulty with the present low frequency range system. In addition, the employment of VHF for the new range system makes it possible to obtain many additional receiving channels, thus eliminating objectionable and possibly dangerous interference from unwanted range signals. A still further operational improvement is obtained by virtue of accurate crystal control in the receiver, permitting selection of the desired signal on a spot basis, the familiar "coffee grinder" giving way to a step switch allowing quick and precise selection of the desired facility.

The operating range of the VOR station is limited to line of sight, which means that good coverage extends out to approximately 140 miles on either side of the station at an altitude of 10,000 feet with correspondingly increased or reduced ranges as the altitude is raised or lowered. Stations will be installed at intervals of approximately 90 miles, thus giving continuous coverage at all practical flight altitudes.

For purposes of explanation a comparison will be made between the present four-course low frequency range and the new VOR system. Figure 1 shows a four-course range and an ADF equipped aircraft using this facility. It will be seen that the low-frequency range gives the pilot choice of four fixed tracks over the ground on which he can fly by the familiar process of merging the A and N signals into a continuous tone which defines the course or beam or range leg.

When flying in one of the quadrants, the pilot must be able to quickly find his way to the desired range leg, or he may wish to fly directly to the station without reference to the range leg. For this purpose the ADF gives continuous relay bearings, and the pilot is thus able to locate the station immediately by reference to the pointer end of his ADF needle. He may then choose a heading which will cause him to intersect the desired range leg, and then may turn down this course toward the station, or he may fly directly to the station from his present location. If he wishes to fly directly to the station without using the range leg, two methods are available to him - first, he can follow the needle to the station on a strictly homing course, in which case his track over the ground will be influenced by any cross wind which may exist; or second, he may decide to fly from his present position to the station over a definite ground track, in which case he sets up the rotatable scale of his ADF indicator to zero it with his magnetic heading. He then reads under the ADF needle the

magnetic bearing from the aircraft to the station, and by turning the aircraft to this magnetic heading and making necessary correction for crab required to offset cross wind can proceed along a definite ground track to the station.

These operating methods in connection with the low-frequency range are well known, but are restated here for comparison with the flight methods possible on the VOR system shown in figure 2. Here we see a radio range which produces an infinite number of tracks. The pilot can choose to fly on anyone of these tracks as shown in the airplane at A. The desired track is selected by choosing the desired track on the omni-bearing selector, the flight of the aircraft then being controlled by observation of the vertical needle of the deviation indicator, which is flown with the same technique employed in guiding the airplane along the localizer during instrument approach.

Information in ADF style is also available to the pilot from the needle of the radio magnetic indicator shown in the airplane at B. Through suitable arrangements which will be described later, the needle of the radio magnetic indicator points directly toward the station, just as does the needle of the ADF on the present low-frequency radio ranges. As a refinement, the azimuth scale of the radio magnetic indicator is automatically synchronized with the magnetic compass through a servo amplifier link. The pilot is thus able to guide his airplane by homing, directly to the station, or he may use the radio magnetic indicator to fly a particular track by observing the magnetic bearing to the station which he reads on the RMI scale underneath the arrow end of the needle. By turning the aircraft to this magnetic heading and making necessary crabbing corrections, a definite track may be flown to the station.

From the description above, it is seen that the indications of the RMI can be used to establish a ground track, and this instrument thus to some extent duplicates the track flying facilities offered by the omni-bearing selector and the deviation indicator needle. A little thought on this instrumentation arrangement will show, however, that a much more precise job of flying a selected line can be done by using the deviation indicator, since a small error in the aircraft's position with respect to the selected track shows up as a large movement of the deviation indicator needle. When using the radio magnetic indicator to fly a track, a displacement of the airplane from track by a few degrees shows up as a very small movement of the RMI needle over its synchronized magnetic scale. It might be said that the deviation indicator provides a vernier method of flying a selected track, while the RMI provides continuous orientation and a simple means of displaying heading and course information to the pilot but with reduced precision of track flying.

Figure 3 shows the omni-bearing selector. A knob A is used by the pilot to rotate a counter type dial to set up the desired flight track. The instrument sensing is arranged so that the pilot flies heading to the station. For example, if the pilot were southeast of Newark, and wished to fly on the radial connecting him with Newark, he would set up 315 on his track selector; that is,

he would set up a track leading away from him at an angle of 315 degrees, and pass directly over Newark. The needle at the top of the track selector would then move up and point to the word TO indicating that the instrument should be read "Track 315 to the station."

Having made the track selector setting, the pilot then flies his right-left needle on the deviation indicator, this needle always pointing toward the track. If the airplane is off course to the right, the needle points to the left, indicating that the desired track line is located to the left of the airplane, and telling the pilot that his aircraft should be maneuvered to the left to get onto the desired course line.

Continuing flight on the desired track, the aircraft passes over the station. In low-frequency range practice, passage over the station is indicated by the familiar cone of silence, the flashing of the marker light from the Z marker and the 3000 cycle tone in the pilot's headset likewise furnished by the Z marker. The marker function in the VOR system is provided by the TO-FROM indicator, which has in the past been improperly named the ambiguity indicator. This instrument should be considered strictly as a marker. On passage over the station, the needle moves from TO to FROM, and the track selector is then read by the pilot "315 degrees from Newark," which is an accurate description of the pilot's angular position with respect to the Newark station. Continuing northwest from Newark on track 315, the pilot may wish to execute a procedure turn and return to Newark along the same track. At an appropriate distance out on the 315 track, the pilot executes his procedure turn, and somewhere during the last half of this turn switches knob B on the track selector. This knob moves a shutter in front of the counter numerals obscuring the figures 315 and revealing the figures 135. At the same time an internal switch in the instrument, operated by the same knob, reverses the TO-FROM indicator which now switches over and points to TO. The pilot then reads his Omni-Bearing Selector as magnetic bearing "135" to the station. Pilots familiar with localizer flying will remember that when an airplane flies a reverse heading on a localizer, the cross pointer sensing is reversed. This is not the case in omnidirectional range flying. When the pilot completes his procedure turn, and reverses his selector through the operation of knob B, as described, not only does the selector tell him the track to the station, but it likewise reverses the deviation indicator readings so that follow-the-needle type of sensing is still correct.

Sensing is always normal when flying along a line somewhere near the selected track, on a heading which approximately agrees with the track selector reading.

The radio magnetic indicator is shown in figure 4. This instrument is universal in character, and may be used with either the VOR receiving equipment or as an indicator for one or two ADF's. Considering it as an ADF indicator first, it behaves just as the present-day compass repeater on the instrument panel with the addition of a stabilized magnetic scale. The stablized

scale behaves as though there were a third crew member who busied himself in continuously resetting the scale of the indicator to agree with the magnetic compass. This continuous resetting or synchronizing service is performed in the RMI by a servo motor coupled to the magnetic compass through a suitable amplifier, included as part of the VOR receiving equipment. In the photograph shown, the double bar needle is pointing to a station to the left and ahead of the aircraft. The magnetic bearing of that station from the aircraft is 206 degrees. The bearing of the aircraft from the station (read on the other end of the same needle) is 26 degrees; in other words, the airplane is northeast of that station. The aircraft's heading is 256 degrees magnetic. The single barred needle is pointing toward a station which is to the right and ahead of the aircraft, the bearing of the station from the aircraft being 312 degrees. It can be seen that the full story with respect to magnetic and radio bearings is portrayed in simple form on a single instrument.

The system layout of the VOR receiving equipment provides for coupling either one of the RMI needles to the Omni-Range Receiver so that direct ADF type bearings can be taken on omni stations. It is probable that the individual airline will work out switching arrangements which will make it possible for the pilot to put, say, the double barred needle on the VOR equipment and the single barred needle on the standard ADF, or to make other use of the needles as desired.

Figure 5 shows typical instrument readings which would be observed in an airplane flying toward radial 305 in a Northerly direction, and then turning left to fly over the station along this same radial.

Starting at A, it will be seen that the needle of the RMI points to the omni station at the left, the bearing to the station being approximately 320 degrees. The magnetic scale of the RMI reads zero, since the airplane is flying directly North. The pilot, knowing that he wishes to approach the station along radial 305 has set his Omni-Bearing Selector to read 305, TO. The vertical needle of the deviation indicator (cross pointer indicator) reads to the right.

The airplane proceeds north to point B. It will be seen now that the needle of the RMI has swung still further to the left, and now reads 308 degrees. The azimuth card of the RMI is still reading zero as the airplane is still headed straight North. The vertical needle of the deviation indicator has swung in close to the center, showing the airplane is close to the desired track. At this point the pilot starts to turn to the left, and arrives at point C, whereupon the needle of the RMI reads 305, but is now pointing dead ahead indicating that the station is directly ahead of the pilot. The magnetic scale of the RMI reads 305 also. The vertical needle of the deviation indicator is now centered showing that the airplane is accurately established on course.

Figure 6 shows a plane as having passed over the station on track 305, the pilot's intention being to proceed along that track to an intersection with a landing system localizer at his terminal field. At point D, the pilot's instruments show that he has just passed the station, but that he has slipped a little bit to the right of his desired track. The RMI needle has reversed, and points back toward the station which now bears 160 degrees from the plane, while the outer scale of the RMI shows 307 degrees, indicating that the pilot's heading is slightly in error to the right. The vertical needle of the deviation indicator points to the left showing that the desired flight track is to the left of the airplane. The ambiguity indicator or TO-FROM needle has been moved down to indicate FROM. The track selector reading is now "305 degrees from the station." The airplane proceeds, readjusting itself to the correct track line, until it arrives at point E. whereupon the pilot operates his frequency selector to pick up the localizer and glidepath of the ILS at the terminal. This frequency might be 109.9, for example. The instruments now read as follows: The needle of the RMI is now dead, since the receiver has been switched away from the VOR station. The scale of the RMI is still in operation and shows the heading of the aircraft to be 305 degrees. The deviation indicator reads to the left showing that the desired runway line lies to the left of the airplane's present position. In the simple case chosen, the inbound runway heading is zero degrees magnetic. The track selector is now inoperative, and the TO-FROM needle has swung to a neutral or centered position informing the pilot that he is to disregard the readings or setting of this instrument.

The pilot proceeds to point F, where his instrument readings are approximately the same as shown at E, except that the deviation indicator needle will have moved in toward center, showing that he is approaching the desired course line. From this point on, he proceeds with his landing, using normal ILS technique without further reference to the VOR system.

Figure 7 shows the operation and use of the instruments during a procedure turn shortly after passage over a VOR station. In this example, the plane is shown at A, proceeding northeast along track 45. The start of the procedure turn is at point B. Instrument readings at points A and B are the same. The needle of the RMI points directly aft toward the station. The RMI dial reading under the needle is 225 degrees. The deviation indicator reads on-course, The needle on the track selector reads FROM, and the complete reading of this instrument is magnetic bearing 45 degrees from the station.

At point B, the pilot turns 45 degrees right, and begins his standard procedure turn. The point C, the needle of the RMI still points back toward the station which is now to the right rear of the plane. The heading of the airplane is now 45 degrees to the right of 45, or 90 degrees. The bearing of the station from the plane is now 240 degrees, and this bearing is read off under the needle end of the RMI pointer. The deviation indicator reads strongly to the left, showing that the pilot has moved well to the right of his original VOR track.

The pilot now starts his standard rate turn to the left, and at point D approximately half way around the turn, switches the shutter of his track selector so as to set up his deviation indicator for normal sensing, on his inbound flight. The RMI needle now points to the station which is over the airplane's left wing at a bearing of approximately 230 degrees. The airplane is still in its standard turn, and its heading at this moment is 315 degrees. The deviation indicator has now swung far to the right indicating that when the pilot approaces the end of his standard turn, the desired course line will lie to the right. The track selector shutter switch has been thrown to the left to reverse the track selector reading which now reads magnetic bearing 225 to the station.

At point E, the plane is headed almost directly toward the station, and is nearly on the desired approach track. The RMI needle shows that the station is slightly to the left of the nose of the plane at a bearing of 227 degrees. The heading of the plane at this moment is 232 degrees, and the pilot still has 7 more degrees of his turn to complete. From this point on in to the station, the pilot flies track 225 in a normal manner.

From all of the explanation and illustrations given, it will be shown that the VOR is simply a visual range which can be swung around to suit the pilot to give him a visual track in any direction leading toward or away from the station. At the same time the system is tied in with the magnetic compass to produce readings on the radio magnetic indicator identical to those which he has been accustomed to using in ADF procedure. The previous knowledge which the pilot has gained in flying ILS localizers and in ADF procedure work should enable him to adapt himself to the VOR system with little difficulty.

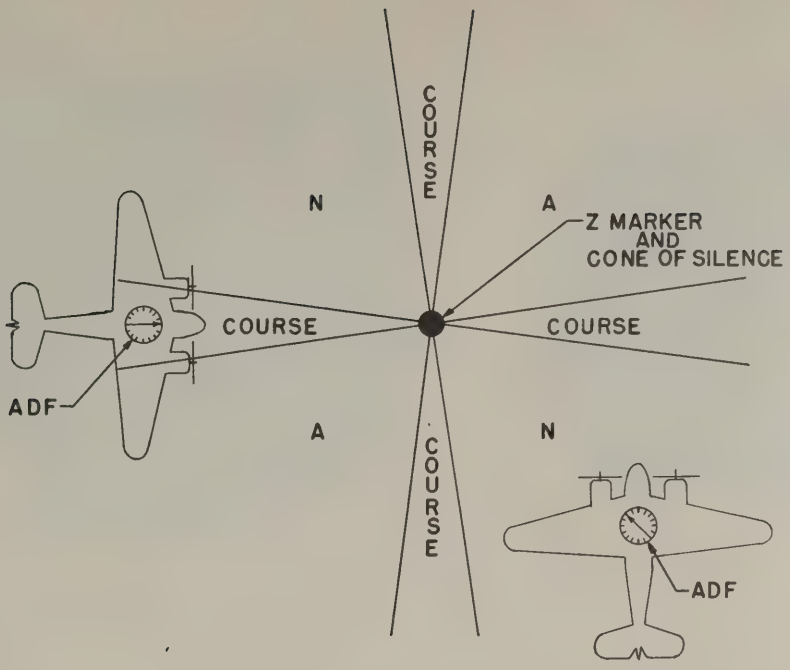


Figure 1 Four-Course Range

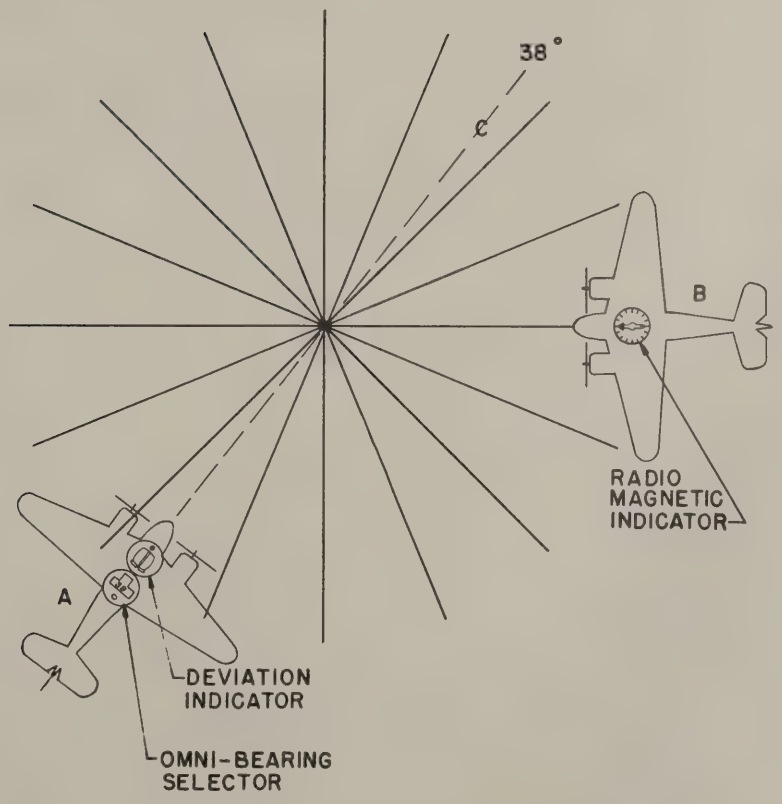


Figure 2 Visual Omni-Range

FIGURE 3 OMNI-BEARING SELECTOR

FIGURE 4 RADIO MAGNETIC INDICATOR

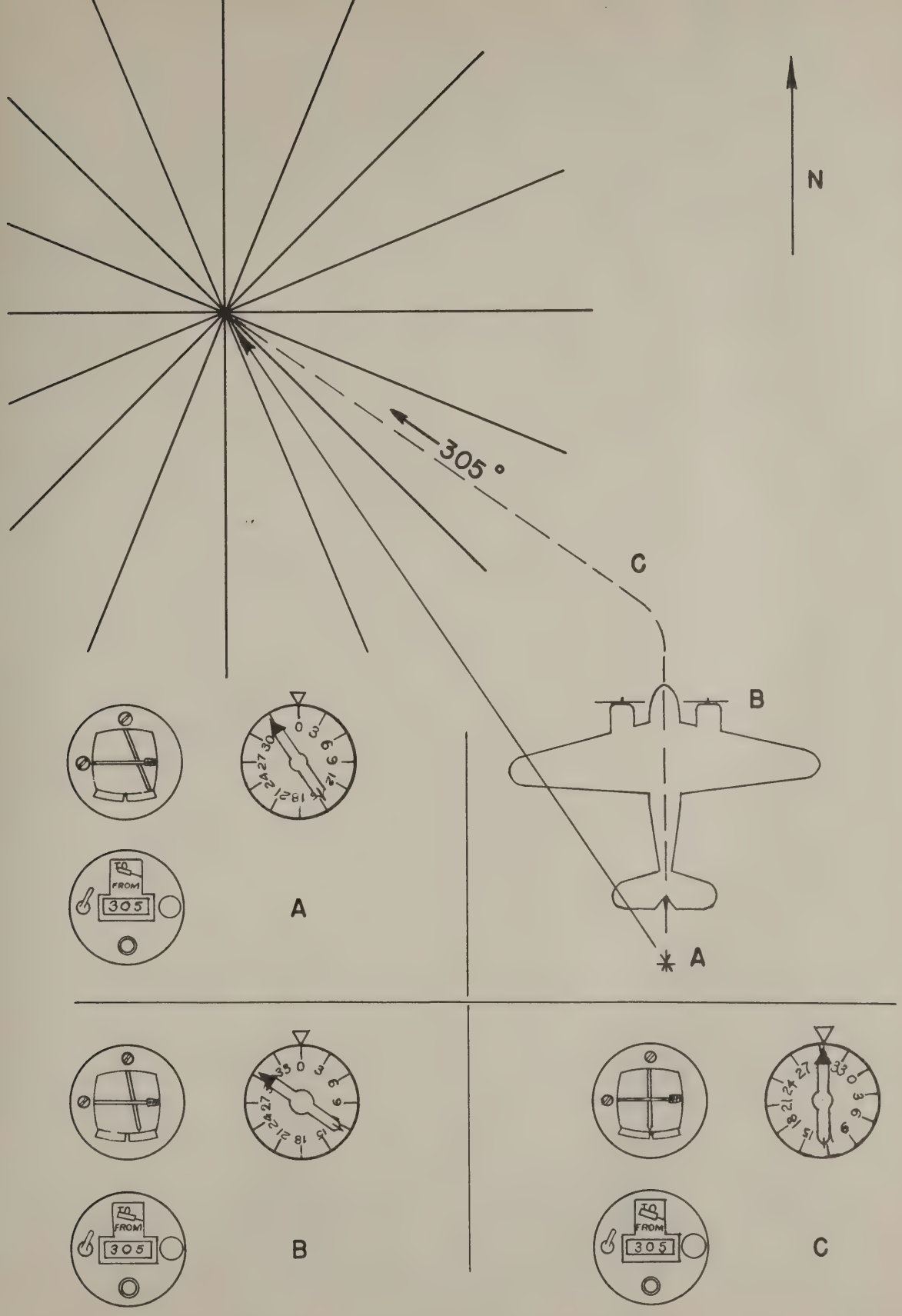


Figure 5 Typical Instrument Readings -
Flying Toward Radial 305

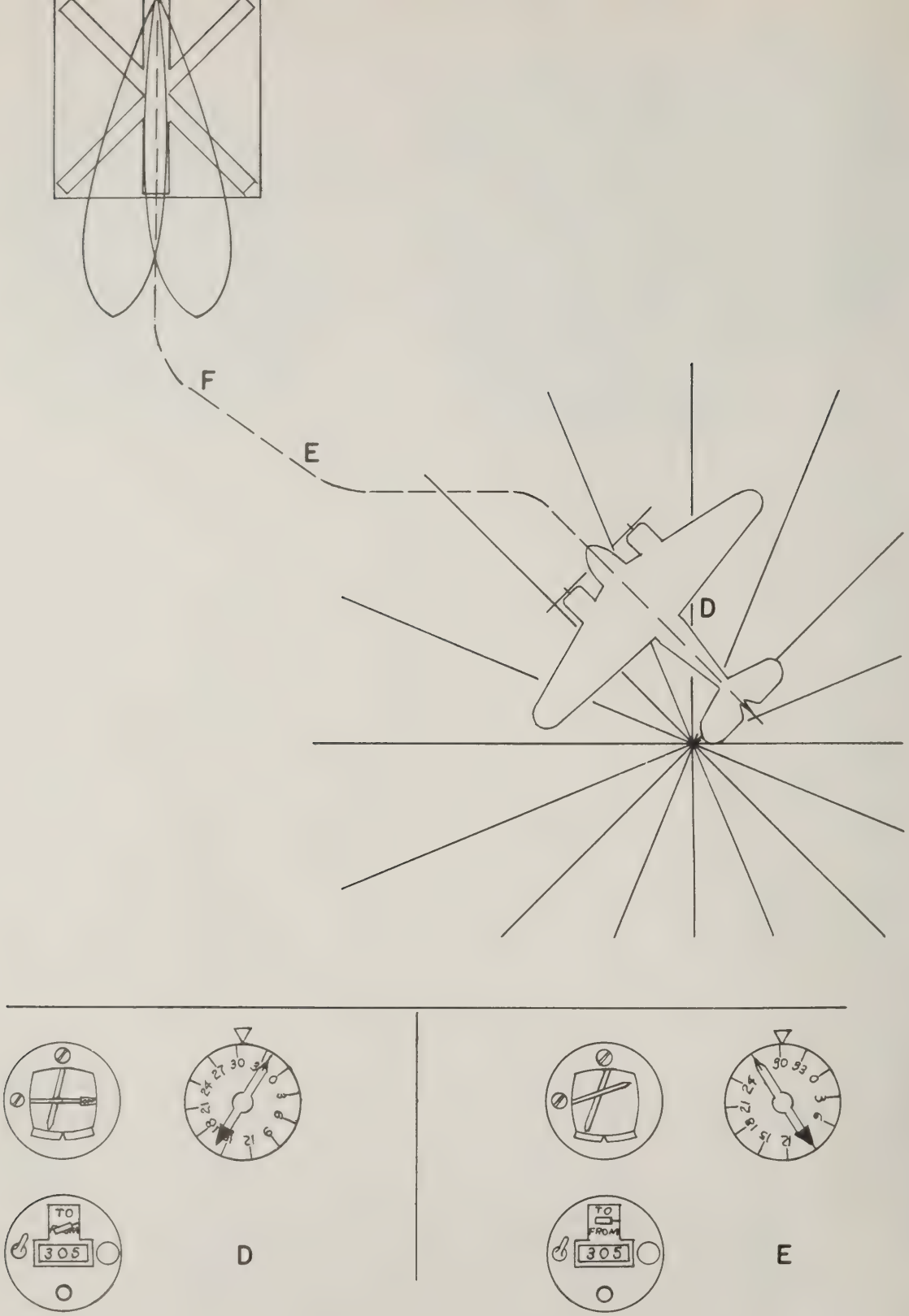


Figure 6 Typical Instrument Readings -
Passed Over Station on Track 305

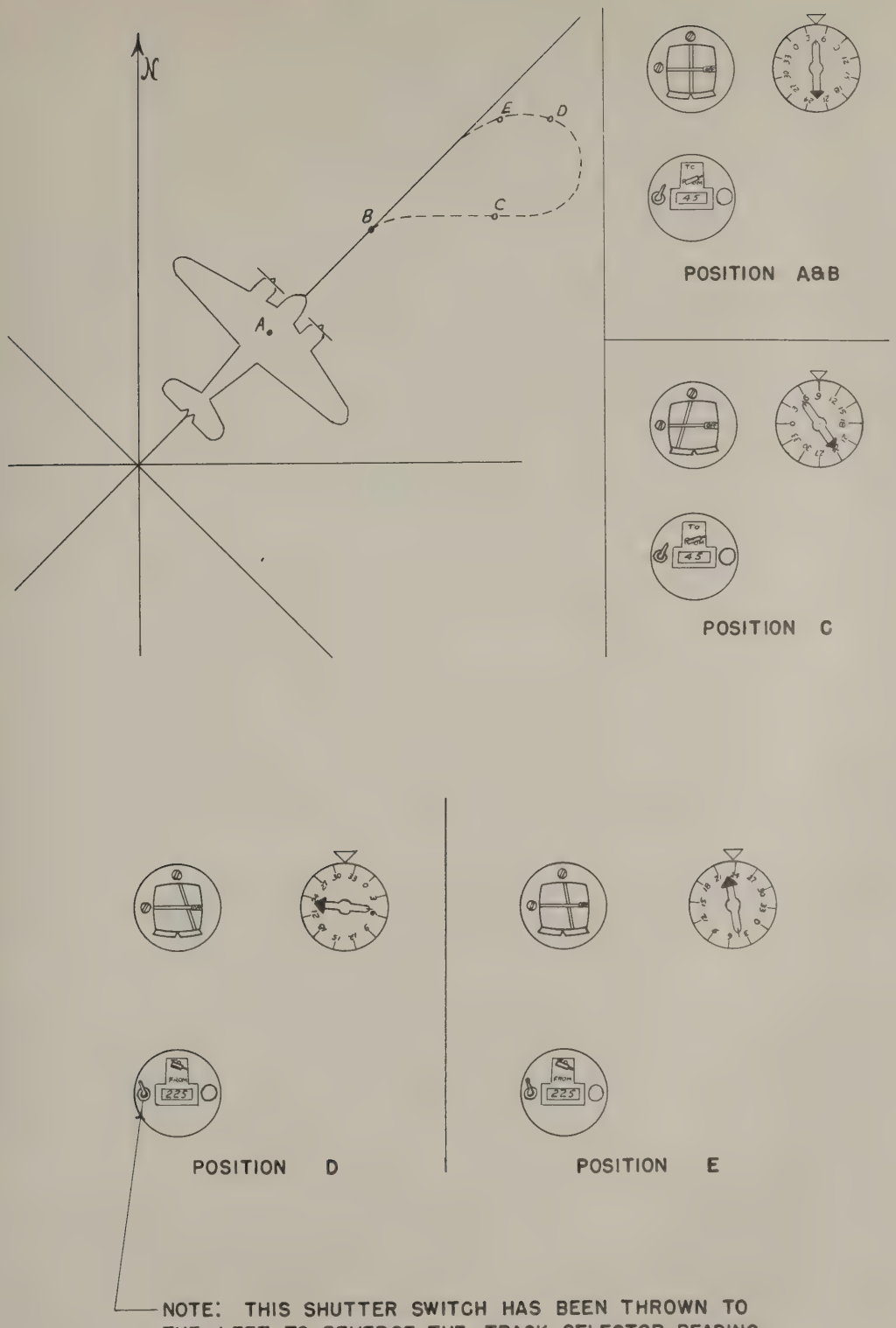


Figure 7 Typical Instrument Readings - Turn After Passage Over Station

SECTION 1

GENERAL DESCRIPTION

1.1. GENERAL.

1.1.1. PURPOSE OF EQUIPMENT. - The Model 51R-2 Navigation Receiver has been designed to fulfill the navigation and communication requirements of all types of military, commercial and private aircraft using the 108 to 136 mc band. Facilities are included for reception of all range, localizer, and voice signals in this portion of the vhf spectrum. The 51R-2 Receiver covers the band 108 to 136 mc on a 100 kc channel separation basis. Any one of the 280 separate channels so obtained may be selected. The pilot's selection is made by two dials, the readings of which are combined to read directly in frequency. The receiver, including instrumentation circuits, is mounted in a case of 1/2 ATR size. The power supply is external.

1.2. ELECTRICAL DESCRIPTION.

1.2.1. INSTRUMENTATION. - The 51R-2 Receiver provides instrumentation facilities for the following:

(a) Localizer - tone type (including flag alarm.)

(b) Localizer - phase type (including flag alarm.)

(c) Omni-directional ranges - automatic indication through selsyn differential, giving combined ADF and magnetic compass presentation of radio magnetic indicator.

(d) Omni-directional ranges - indicating on cross-pointer meter, course chosen by a manual bearing selector; includes operation of a TO-FROM indicator; flag alarm operated from reference phase channel.

The tone localizer functions of the receiver are straightforward and are comparable to those provided in the USAF RC-103 equipment now installed in many transport aircraft. Item (b) of the above list is a facility to permit the use of phase type localizers which are expected to come into general use within the next few years. Phase type localizers provide indications identical to those obtained from present day localizers.

The instrumentation of item (c) presents all information available from the omni-directional range system. As a result of combining omni-directional range and magnetic data through a differential unit, the pilot is provided with a pointer which reads heading to the station against a stabilized magnetic scale. This presentation is the same as is given by the present day automatic direction finder (ADF) with the addition of a stabilized magnetic scale.

The instrumentation in (d) is an aid in track flying in which a bearing selector is provided which permits the pilot to set up the range leg on which he wishes to fly. Flight directions from the selected leg are shown on a cross-pointer indicator. As a further aid to track flying, the TO-FROM indicator has been provided. The simplest way to understand this instrument is to think of it as a station marker which reads TO until you reach the station and switches over to FROM when the station has been passed. With the full automatic ADF type presentation in use, however, the TO-FROM indicator can be ignored, since the aircraft's location with respect to the station will be shown clearly and unmistakably by the action of the ADF type pointer on the radio magnetic indicator.

The voltages which actuate the cross-pointer indicator when flying on a selected track or range leg are of the character required to couple into the new type electronic automatic pilots, thus permitting automatic flight on any desired radial toward or away from the station.

The instruments used to provide the above indicated facilities are as follows:

a & b - Deviation Indicator provides localizer and glidepath indication, plus flag alarm.

c - Omni-bearing Indicator comprises a servo motor driving a resolver and autosyn differential.

c - Radio Magnetic Indicator Collins type 332C-1 or Pioneer type 36101-1.

c - Flux-gate, or Gyrosyn Magnetic Compass equipment is available from Eclipse Pioneer Instrument or Sperry Gyroscope Companies.

d - Omni-bearing Selector including TO-FROM indicator.

1.2.2. RECEIVER.-The 51R-2 Receiver is a double conversion superheterodyne having a tunable first i-f of 19.5 to 21.4 mc and a second fixed i-f of 3.2 mc. Injection frequencies for the first converter are obtained from a group of 14 crystals which are selected by a tap switch driven by the megacycle Autopositioner. This positioner tunes the crystal multiplier circuits as well as the four tuned circuits in the r-f amplifier which precedes the first converter. Injection frequencies for the second converter are supplied by a group of 20 crystals and are selected by a switch driven by the tenth-megacycle Autopositioner. The tenth-megacycle Autopositioner simultaneously tunes the second injection crystal multiplier circuit as well as the four tuned circuits associated with the first (tunable) i-f amplifier.

Tracing from the antenna, all signals received in the selected 2 mc band pass through a tuned circuit to an r-f amplifier, and thence through a

pair of tuned circuits to the first converter. The first converter is supplied with an injection voltage of suitable frequency to heterodyne the signal down to a frequency within the 19.5 to 21.4 mc band of the first i-f amplifier. The first i-f amplifier is tuned to the specific frequency desired and this frequency is thus selectively amplified and fed to the second frequency converter where it is mixed with an injection voltage obtained from the second crystal group. The output frequency of the second converter lies in the middle of the 3.2 mc second i-f amplifier pass-band, and is selectively amplified and passed to the detector.

Reduction of image is accomplished through suitable selection of intermediate frequencies and by the employment of three tuned circuits ahead of the first mixer and a tunable high frequency i-f amplifier ahead of the second mixer. Special attention has been given to the problem of rejecting interference from high power television and FM services. The receiver has been arranged so that in addition to the high image rejection, there is no point within the navigation coverage of the receiver at which image interference could be encountered from either the FM or television services.

Rejection of unwanted frequencies other than the image is accomplished by (1) adequate selectivity in both crystal multiplier systems, (2) careful choice of i-f and crystal frequencies, (3) the use of high Q tunable i-f transformers and (4) adequate shielding and bypassing of all circuits involved. The selectivity of the tunable i-f amplifier section is such as to provide considerable attenuation to adjacent channels and high attenuation to channels further removed in frequency. Thus, cross modulation is virtually eliminated from the second mixer. The aural output stage provides a maximum output level of 300 milliwatts into a 500 ohm circuit. Since interphone systems may require 50 milliwatts or less, the output of Z101, the high pass aural filter, will need to be tapped down. This is done by adjusting potentiometer R156, located in the grid circuit of the audio output amplifier, V110.

The final selectivity required to insure adequate rejection of adjacent channel signals is provided by the second i-f amplifier which operates at 3.2 mc. The 3.2 mc i-f amplifier has a 6 to 60 db ratio of 50-155 kc, which, combined with the selectivity obtained in the first i-f amplifier gives overall rejection of 70 db to the adjacent channel under worst conditions of frequency drift of both receiver and transmitter. Assuming that both receiver and transmitter are operating on frequency, the adjacent channel rejection is 80 db.

A diode detector and series diode peak clipping type noise limiter is included. This limiter tends to give constant output at any percentage of modulation above the clipping threshold without loss of intelligibility. A tap on one of the frequency selector wafers in the receiver selects the proper audio gain setting for 30% modulated voice signals from navigation facilities, and 100% modulation signals delivered by communication stations This level switching, combined with the inherent leveling action of the noise

limiter, insures close control of audio output at the proper preselected level. A carrier-operated audio squelch is included in the receiver. The instrumentation system requires 26 volts 400 cps a-c. A remote squelch connection is provided.

1.2.3 REMOTE CONTROL SYSTEM. - The frequency control system permits the selection of any one of 280 channels, using 9 control wires in a re-entrant circuit. A motor drive positions either the 2 megacycle or the one-tenth megacycle selector shafts. This mechanism provides for the control of the two selector shafts from a single motor through a pair of over-running clutches and stop mechanisms. Switching time between any pair of frequencies varies from a minimum of 1/10 second to a maximum of 2 seconds. The controls which are provided for the pilot's use are calibrated directly in megacycles and tenths of a megacycle, so that the frequency of the selected channel is read directly from the concentric dials. The pilot's control unit has been arranged to control an associated glide path receiver and distance measuring equipment. The choice of phase or tone modulated localizer service is made by operation of a toggle switch on the remote control unit. 314U-1 gives 3 or 10 channel. 314U-5 gives 3, 10, or 20 channel.

1.3 MECHANICAL DESCRIPTION.

1.3.1. RECEIVER. - The receiver, including r-f, audio, and indicator circuits, is mounted in a case of 1/2 ATR unit size. This is the same size as the Army-Navy JAN-C-172 type A-1-d. All connections with the exception of the antenna enter the receiver through a rear plug, cannon type DPD-45-34P. An extractor is provided on the shockmount to aid in installing and removing the receiver from its rear plug shockmount.

The 90 and 150 cycle filter, together with the resistors and potentiometers which comprise the audio circuits for tone localizers and two-course ranges, are mounted under a detachable cover fastened to the top rear of the receiver case. These components occupy a space immediately above the wiring which is associated with the rear plug mount.

1.3.2. ACCESSORY UNIT. - Installation of the receiver with its associated instrumentation necessitates the inclusion of a number of related accessory items for which mounting provisions must be made. The type 351A-1 accessory unit, which is 1/2 ATR in size, provides mounting space for two type 337A-1 or 337A-2 Radial Converter Indicators, a maximum of three type 333B-1 Radio Magnetic Indicator servo amplifiers and two type 416N-1 Dynamotor Power units for the receivers. This arrangement provides a compact and simple means of installing a group of miscellaneous items. Where a receiver is installed, with full instrumentation, it is recommended that an accessory unit be installed at the same time, thus readying the installation for future addition of a second navigation receiver without extensive revision of the original installation.

1.4 SPECIFICATIONS.

1.4.1 BASIC FUNCTION. - To provide for reception of all aircraft communication and navigation services in the vhf region, between 108 and 135.9 mc.

1.4.2 RECEIVER TYPE. - Double conversion superheterodyne.

1.4.3 INDICATING SYSTEM. - Facilities are provided for the following:

(a) Localizers, tone type, flag alarm.

(b) Localizers, phase type, flag alarm.

(c) Omni-directional ranges, indicating on cross pointer meter, course chosen by radial selector; includes operation of TO-FROM indicator and flag alarm.

(d) Omni-directional ranges, automatic indication through radial converter indicator, giving combined presentation on radio magnetic indicator. This automatic indication feature is operable simultaneously with the cross pointer indication mentioned in (c) above.

(e) The cross pointer meter circuits are designed to feed a load of 330 ohms which provides for a maximum of either three cross pointer meters, or two cross pointer meters plus a 1000 ohms load as presented by automatic flight control equipment. Flag alarm movements are 1000 ohms each.

1.4.4. INSTRUMENTATION.

(a) Flight Path Deviation Indicator - Weston Model 888.

(b) Omni-Bearing Selector - Collins Type 336A-1 or 336A-2 (includes TO-FROM indicator).

(c) Omni-Bearing Indicator - Collins Type 337A-1 or 337A-2

(d) Radio Magnetic Indicator - Collins Type 332C-1.

1.4.5. REMOTE CONTROL SYSTEM. - Two deck, concentric tap switches give decade selection of frequencies. Nine control wires are used between cockpit and receiver for 280 channel selection. The control panel includes toggle switch to choose between phase and tone type localizers: this function requires one additional wire. Basic design permits simultaneous control of glidepath and DME facilities.

1.4.6. FREQUENCY COVERAGE. - 108.0 - 135.9 mc.

1.4.7. CHANNELS. - 280 channels, spaced at 100 kc intervals, are provided throughout the band.

1.4.8. SELECTIVITY, OVERALL. -

Total Band Width	Attenuation, DB
greater than 50 kc	6 db
less than 160 kc	60 db

1.4.9. STABILITY. - 0.007% under all service conditions; i.e., from 0 to 95% humidity, from -55 to +72 degrees C., and with battery voltage variations of ±10%.

1.4.10. UNDESIRED FREQUENCY RESPONSES. - Attenuation of undesired frequencies is as follows:

Image:	Receiver only	75 db
	Including antenna	100 db
Adjacent Channel:		75 db
All other undesired frequencies		80 db

1.4.11. RADIATION. - Where simultaneous parallel operation of receivers on a common VOR antenna is anticipated the customer should first contact the manufacturer giving details relative to the specific installation.

1.4.12. SENSITIVITY. - Three microvolts or better to produce 200 milliwatts output at a signal-to-noise ratio of 6 db or better when the input signal is 30% modulated with a 1000 cycle tone. Screwdriver adjustment of sensitivity control is accessible thru front panel.

1.4.13. AUTOMATIC VOLUME CONTROL. - Flat within 3 db total variation from 5 microvolts to 50,000 microvolts input.

1.4.14. NOISE LIMITER. - Series diode peak clipping type.

1.4.15. SQUELCH CIRCUIT. - Carrier operated; preset threshold adjustment in receiver. Remote control lead available at rear plug pin 35.

1.4.16. AURAL OUTPUT. - Single channel, 300 mw to 500 ohm circuit.

1.4.17. FIDELITY. - Within 6 db, 300 to 3500 cycles.

1.4.18. INPUT. - 52 ohms coaxial.

1.4.19. MECHANICAL. - 1/2 ATR case size (JAN A-1-d). All connections except antenna, enter receiver through rear plug; cannon type DPD-45-34P. Mechanical design of mounting includes extractor to ease separation of receiver from shockmount.

1.4.20. POWER SUPPLY. - Dynamotor power unit, 416N-1 or 416N-2, external to receiver; 28 volt dc supply standard; 14 or 28 volt operational optional through use of dual input type dynamotor, 416N-2.

D-C Power requirements: 5 amperes at 28 volts (416N-1 or 416N-2) or 11 amperes at 14 volts (416N-2)

A-C Power Requirements: 0.2 ampere, 26 volts, 400 cycles a-c, for full automatic instrumentation.

1.4.21. ACCESSORY UNIT. - Type 351A-1, 1/2 ATR case providing mounting space for two omni-bearing indicators, Type 337A-1; a maximum of three RMI servo amplifiers, Type 333B-1, together with a maximum of 2 dynamotor power supply units, Type 416N-1. This unit is wired ready to receive the accessories mentioned, and all connections are brought in through a standard cannon DPD-45-34P rear plug. Mechanical design of mounting includes extractor to ease separation of accessory unit from shockmount.

1.4.22. WEIGHT. - The weights of the various system units are as follows:

Receiver, Type 51R-2	28 lbs
Shockmount for 51R-2	2 lbs 10 oz
Accessory Unit, Type 351A-1	7 lbs 5 oz
Shockmount for 351A-1	2 lbs 10 oz
Servoamplifier, Type 333B-1	2 lbs
Power Supply, Type 416N-1	6 lbs
416N-1 with Separate Mtg Base	9 lbs 5 oz
Power Supply, Type 416N-2	10.6 lbs
Control Box, Type 314U-1 or 314U-5	0.7 lbs
Flight Path Deviation Indicator, Type ID-48/ARN	1.87 lbs
Omni-bearing selector, Type 336A-1 or 336A-2	2 lbs
Omni-bearing Indicator, Type 337A-1 or 337A-2	2.5 lbs
Radio Magnetic Indicator, Type 332C-1	2 lbs
Antenna, Type 37J	5 lbs

1.4.23. TUBE TYPES - 5654 (ruggedized 6AK5)
5751 (ruggedized 12AX7)
5814 (ruggedized 12AU7)
5726 (ruggedized 6AL5)
OA2

1.4.24. SHOCKMOUNTS - The 51R-2 receiver is Type Certificated for operation on shockmount 504 3713 00. This same mount will handle singularly the 51R-1, the 351A-1 loaded with one power supply, one OBI, and one RMI servo amplifier, or the 351A-1 loaded with two power supplies, two OBI's and either two or three RMI servo amplifiers.

SECTION 2

INSTALLATION

2.1. INSTALLATION.

2.1.1. PRELIMINARY.

(a) Unpacking. - Remove all packing material and lift unit out carefully. Inspect unit for apparent damage, loose screws or bolts. Be certain all controls, such as switches, knobs, etc., work properly. All claims for damage should be filed promptly with the transportation company. If a claim for damage is to be filed, the original packing case and material must be preserved.

2.1.2. GENERAL.

(a) TYPES OF INSTALLATION. - The purpose of this section of the instruction book is to describe the several different types of installation that are possible with the 51R-2 Navigation Receiver and its accessories.

(1) Minimum Instrumentation Installation. - Refer to figure 2-1. This illustration shows a typical installation with a 51R-2 Receiver and instruments and gives some idea of the cabling required for this type of installation. This type of installation may be required for certain types of air service.

(2) Full Instrumentation Installation. - Refer to figure 2-2. Two receivers, two sets of instruments and one accessory unit are provided. It should be understood that with either a two or three instrument installation that it is not necessary to use a separately mounted (416N) power supply. If it is desired to use the accessory unit (351A-1) then the (416N) power supply will be mounted inside the accessory unit.

(3) Installation Procedure, Mechanical.

a Receiver Mounting (51R-2). - Refer to figures 2-3 and 2-4. These drawings give the outline and mounting dimensions of the receiver dust cover and the shockmount. When mounting the receiver, the minimum clearance on the sides should be two inches and a minimum of 4 inches should be allowed in front and rear of the unit. This allows the receiver to be removed with ease and allows space for cables in the rear. Adequate ventilation should be provided to insure optimum performance. Normal receiver temperature rise in still, open air is 25°C.

b Accessory Unit Mounting (351A-1). - Refer to figures 2-4 and 2-5. These illustrations give the outline and mounting dimensions of the Accessory Unit and the shockmount. The shockmount is the same as that for the receiver except for the connector plug. The Accessory Unit should be mounted beside the receiver for convenience in wiring. A minimum of two inches should be allowed on both sides of the accessory unit for free swing on the shockmount. A minimum of four inches should be allowed in front and in the

rear of the accessory unit. This allows removal of the accessory unit from the shockmount and allows enough space in the rear for the interconnecting cable.

c Power Supply Mounting (If used in place of Accessory Unit) (416N). Refer to figures 2-6, 2-7 and 2-8. These illustrations give the outline and mounting dimensions of the 416N Power Supply. A clearance of 5/8" is required at the top of the power supply to facilitate the removal of the unit from the base. A clearance of approximately 4 inches is required for removal of the power plug from the supply.

d Servo Amplifier (333B-3). - Refer to figure 2-10. The servo amplifier has two possibilities for mounting. If an Accessory Unit 351A-1 is used, the servo amplifier will be mounted in the accessory unit as shown in figure 2-5. However, if no accessory unit is employed then the servo amplifier can be mounted in any convenient out-of-the-way place.

e Frequency Control Unit Mounting (314U-1 or 314U-5). - Refer to figure 2-9. This illustration shows the dimensions of the cutout required to receive the control unit.

f Instrument Mounting. - All instruments should be mounted in convenient places on the instrument panel.

1 Deviation Indicator (ID-48). - Refer to figure 2-11. This illustration gives all necessary information for mounting.

2 Omni-bearing Selector (336A-1 or 336A-2). - Refer to figure 2-12. This illustration gives all information necessary for mounting.

3 Omni-bearing Indicator (337A-1 or 337A-2). - Refer to figure 2-13. This illustration gives all information necessary for mounting.

4 Radio Magnetic Indicator (332C-1). - Refer to figure 2-14. This illustration gives all information necessary for mounting.

(4) Antenna Installation. - The 51R-2 Navigation Receiver has a 52 ohm input. The 37J Deerhorn Antenna is designed to receive horizontally polarized waves from 108 to 122 mc with a 52 ohm coaxial output. It will also receive circularly polarized transmission from ground to air in the 118 to 122 mc tower spectrum. Vertically polarized waves from 122 to 136 mc should be brought in to the receiver from a vertical antenna, such as the familiar AN-104. By jumpering S103 clip 7 to S103 clip 9 the antenna changeover relay can be automatically actuated at 118 mc instead of 122 mc as it is wired at present.

Best localizer and omni-range reception for minimized propeller modulation and course pushing effects is obtained with the 37J Antenna mounted atop the vertical rudder, as proven by experimentation. These experiments did not go into the results of severe icing conditions, nor static discharge effects. The second best place for the antenna is atop the fuselage over the cockpit but tail shadow causes nearly 19 db. signal strength attenuation. The 37J is

mechanically interchangeable with the USAAF AS/27A ILS Deerhorn antenna. The maximum standing wave ratio it causes due to impedance mismatch at the frequency extremes is 5 to 1.

Because the Collins 37J Antenna does not provide for glide path reception, the Collins 37P Antenna is recommended. This antenna has a 52 ohm coaxial receptacle which will connect to an R-89B/ARN-5 Receiver with 52 ohm coaxial cable into the receiver's twin lead receptacle. The 37P has an increase in voltage pick-up strength of 6 to 10 db. over the dipole on the AS/27A. Tests show that the impedance mismatch caused by connecting to the 100 ohm twin lead receptacle (with one side grounded) of the R89B with a 52 ohm coaxial cable is no greater than that obtained with 90 ohm twin lead so that all of the 6 to 10 db. increase is realized.

The 37P was designed to mount horizontally $\pm 30^{\circ}$ on the nose of the aircraft with its 52 ohm coaxial receptacle protruding through the mounting surface inside the skin of the ship.

(5) Installation Procedure, Electrical.

a Receiver Connections. - Refer to figures 2-17 and 2-18.

CAUTION

The wiring cable should have enough slack to permit free movement on the shockmount.

b Accessory Unit Connections. - Refer to figures 2-19 and 2-20.

CAUTION

The wiring cable should have enough slack to permit free movement on the shockmount.

c Power Supply Connections. - Figure 2-24 shows the schematic of the 416N-1 Power Supply for use with 28 volt d-c supply. The separate mounting base shown is for use when the 416N-1 is not mounted in Accessory Unit 351A-1.

The 416N-2 Power Supply, refer to figure 2-25, is intended for use with 14 volt d-c aircraft supply, but may also be used with 28 volt d-c source. The 416N-2 plug connections are electrically interchangeable with the 416N-1 (separately mounted.) The 416N-2 is not adapted to mounting on the 351A-1 Accessory Unit.

d Servoamplifier (333B-1 and 333B-3). - Refer to figure 2-26. This illustration shows the connections necessary for the servoamplifier. When used with a separate mounting base, the 333B-1 is designated as 333B-3.

e Remote Control Unit (Type 314U-1 or 314U-5). - Refer to figure 2-21 and 2-22.

f Instrument Connections.

1. Deviation Indicator (ID-48). - Refer to figure 2-11. The loading for the cross pointer circuits should be maintained at 333 ohms on the vertical needle circuit and 500 ohms on the flag alarm circuit. Compensation should be used if necessary to maintain these values.

2. Omni-bearing Selector (336A-1 or 336A-2). - Refer to figure 2-12.

3. Omni-bearing Indicator (337A-1 or 337A-2). - Refer to figure 2-13.

4. Radio Magnetic Indicator (332C-1). - Refer to figure 2-14.

To simplify the service problem, when more than one type of RMI is used, the RMI servo amplifiers have been made identical and an autotransformer Collins Part No. 677 0255 00, has been designed to match the HIZ motor winding of Pioneer RMI Type 36101. Figure 2-27 shows the autotransformer and the adapter cable that make the RMI's interchangeable. This hookup necessitates a change in the Kearfott RMI consisting of lifting the internal ground from pin V.

g Antenna Connection. - Antenna connections are made with coaxial lines from antenna to receiver.

h Connecting to Airplane Primary Voltage Source. - Four hundred cycle power supplied to the accessory unit should preferably come from an autotransformer, Collins Part No. 672 0262 00. An alternate arrangement can be used where the autotransformers in the 333B-1 amplifiers supply the RMI servo motor and also on autosyn indicator rotor. The 26 volt windings on the 333B-1 autotransformers have a rating of 235 ma at 26 v. Power requirements for autosyn indicator rotors and OBI motor and RMI motor are as follows: (approximate values)

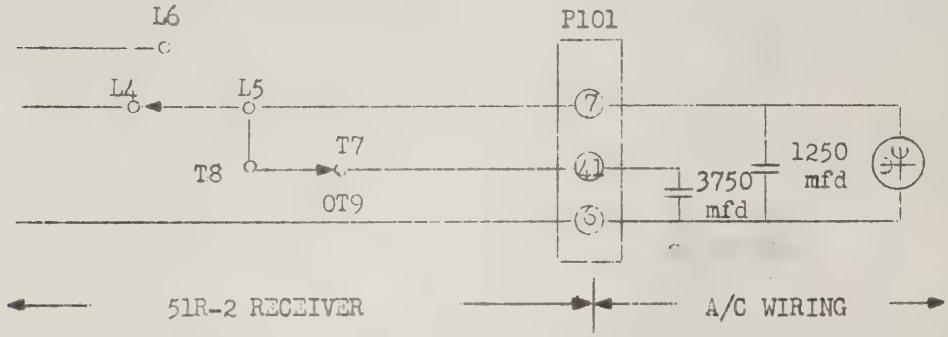
Autosyn indicator rotor - - 100 ma

OBI motor - - - - - - - - - 150 ma

RMI motor - - - - - - - - - 150 ma

i It is recommended that a low voltage non polarized electrolytic capacitor of 1250 mfd be connected directly across the Deviation Indicator to serve as a course wiggle filter. This value is satisfactory for localizer service. It is desirable to have additional filtering on enroute service on the VOR. A figure of 5000 mfd has been found to be satisfactory from service tests.

j A means of automatically selecting the desired filtering capacitor is shown in the figure below. It can be seen that when relay K105 is in the released position 5000 mfd will be connected across the Deviation Indicator. Likewise, when K105 is actuated (as on 90/150 localizer) only 1250 mfd is connected across the Deviation Indicator.



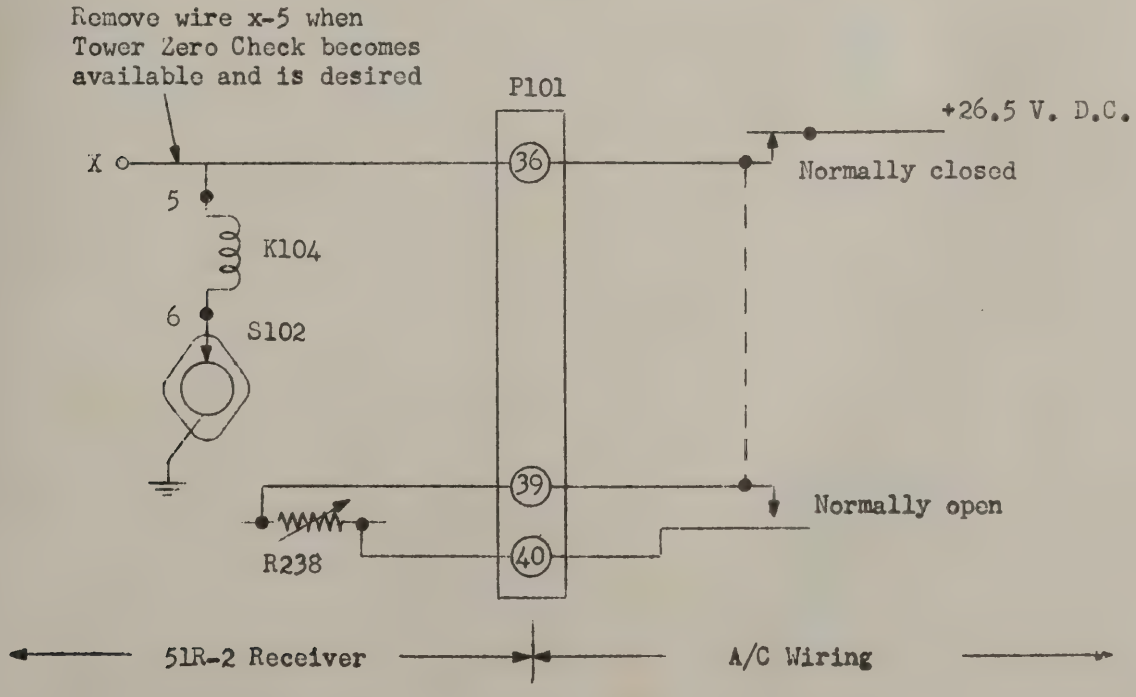
k It is recognized that the above system does not distinguish between VOR and Phase Localizer insofar as wiggle filtering is concerned. This presents no problem until such time as the proposed Phase Localizer goes into operation. At that time the Deviation Indicator filtering control can be automatically handled by means of an external relay actuated by the energizing power available at P101 pin 37 (28 v dc from 108 to 112 mc and 0 v dc from 112 to 118 mc.).

l The installation information outlined in this instruction book covers the installation of the 51R VOR equipment in an aircraft equipped with a Gyrosyn compass. Where the installation must be made in an aircraft equipped with the Eclipse-Pioneer Fluxgate compass, two basic factors must be considered, otherwise considerable confusion will result. The Sperry Corporation, manufacturers of the Gyrosyn, and the Eclipse-Pioneer Instrument people do not employ the same definition of electrical zero. By using the Eclipse-Pioneer definition, it is found that their equipment will be electrically zeroed on North, whereas the Sperry equipment will be electrically zeroed on South. By following instructions outlined herein, the magnetic information from the Fluxgate compass can be effectively reversed without modification of the VOR equipment, and by making the necessary corrections in the planes wiring only. First, the RMI card when using the 333B-1 or 333B-3 servo amplifier will be 180 degrees from its proper bearing. To reverse this, it is suggested that the plane's wiring to the RMI servo motor stator terminals F and J be reversed. This will return the card to the proper zero reading for North magnetic heading.

The second point to be corrected is that the RMI pointers will be receiving South information, and must be reversed 180 degrees. It is recommended that the phase of the 26 volts 400 cps supplied to the RMI pointers be reversed by a 1:1 autotransformer. By connecting the autotransformer between the power source feeding the rotors and effecting the phase reversal, we have not disturbed any other instrumentation in the pilots compartment. Such a transformer is available and carries a Collins part number, 677 0327 00.

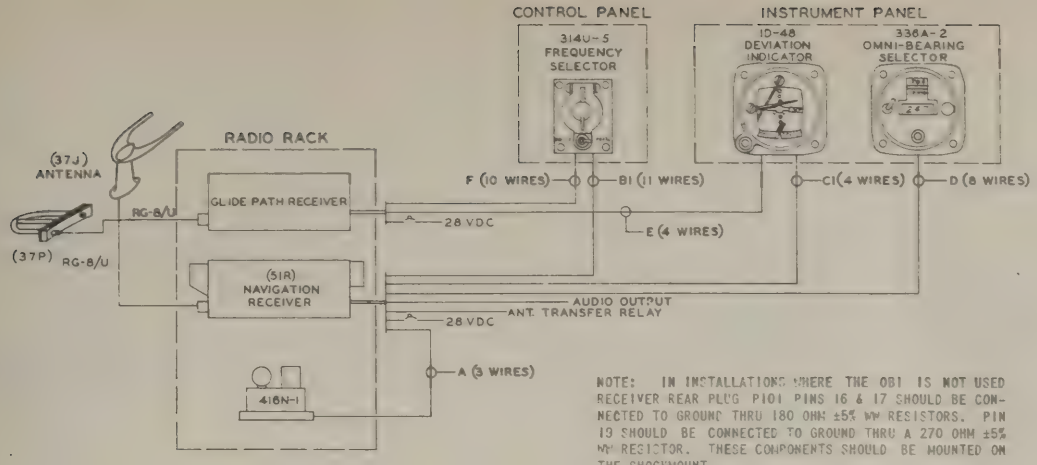
m At the request of ARINC, the 51R-2 receiver has been modified to utilize a proposed Tower Zero Check facility in the frequency range of 118-122 megacycles (Deviation Indicator Only). As this proposal now stands, the facility would be such that omni information corresponding to that obtained on zero radial would be transmitted upon request in an omnidirectional fashion. This facility would be available to any aircraft calling the tower specifically for an inflight Tower Zero Check.

To obtain this indicator circuit check on frequencies which were originally not considered part of the VOR band, it will be necessary for the pilot or co-pilot to actuate a spring loaded switch in the pilots compartment which does two things within the receiver. First, as will be noted from the figure below, the 26.5 volts which is constantly applied through the switch through rear plug P101 pin 36 is relay K104 terminal 5, must be broken inasmuch as K104 will be actuated by virtue of the grounding picked up by S102 in the frequency range 118-122 megacycles. By opening the 26.5 volt power, the relay will release, thus setting up the proper AVC time constants for the navigation facility.



Secondly, it will be noted from data outlined on pages 5-12 and 5-13 that phase localizer sensitivity control R238 must be short-circuited from 118-122 mc if normal VOR deviation indicator sensitivity is to be obtained. Therefore, it will be necessary for the pilot to close a switch connecting pins 39 and 40 of P101 together, and thus effectively short-circuit the control. In the VOR band this is automatically done by switches associated with the frequency selector mechanism.

In order that complete interchangeability can exist between the 51R-2 and 51R-1, wire X-5 in figure is included in all 51R-2 receivers. When and if the proposed Tower Zero Check becomes available, and the concerned customer is interested in utilizing this facility, it will be necessary after accomplishing the external wiring to remove wire X-5 within the set.



NOTE: IN INSTALLATIONS WHERE THE OBI IS NOT USED RECEIVER REAR PLUG P101 PINS 16 & 17 SHOULD BE CONNECTED TO GROUND THRU 180 OHM ±5% WW RESISTORS. PIN 19 SHOULD BE CONNECTED TO GROUND THRU A 270 OHM ±5% WW RESISTOR. THESE COMPONENTS SHOULD BE MOUNTED ON THE SHOCKMOUNT.

CABLE KEY

A - POWER CABLE
- 28 V DC
- 250 DC B+
- GROUND

B - FREQUENCY CONTROL - NAV. REC.
- 9 - WIRES FC.
- TONE-PHASE LOCALIZER
- GROUND

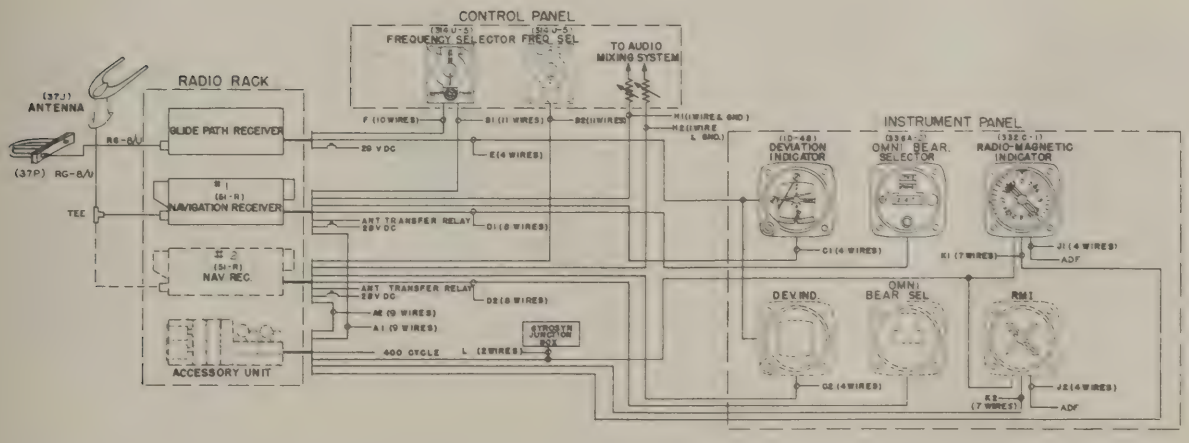
C - DEVIATION INDICATOR - NAV. REC.
- LOC - POINTER
- LOC - POINTER
- FLAG ALARM
- FLAG ALARM

D - OMNI BEARING SELECTOR
- AMBIGUITY METER
- AMBIGUITY METER
- RADIAL SEL STATOR } TWISTED
- RADIAL SEL STATOR } PAIR
- RADIAL SEL STATOR } TWISTED
- RADIAL SEL STATOR } PAIR
- RADIAL SEL ROTOR } TWISTED
- RADIAL SEL ROTOR } PAIR

E - DEVIATION INDICATOR - GLIDE PATH REC.
- GLIDE PATH POINTER
- GLIDE PATH POINTER
- FLAG ALARM
- FLAG ALARM

F - FREQUENCY SELECTOR - GLIDE PATH REC.
- CHANNEL SELECTOR WIRES (10)

Figure 2-1 Navigation System, Minimum Instrumentation



CABLE A ACCESSORY UNIT TO NAV. REC.
- 28 V DC
- B+
- GROUND
- MOTOR PHASE
- MOTOR PHASE
- OMNI BEARING INDICATOR STATOR } TWISTED
- OMNI BEARING INDICATOR STATOR } PAIR
- OMNI BEARING INDICATOR ROTOR } TWISTED
- OMNI BEARING INDICATOR ROTOR } PAIR

CABLE B FREQUENCY SELECTOR TO NAV. REC.
- FREQUENCY CONTROL WIRES (10)
- TONE-PHASE LOC. SW.

CABLE C DEVIATION IND. TO NAV. REC.
- LOC. POINTER
- LOC. POINTER
- FLAG ALARM
- FLAG ALARM

CABLE D OMNI BEAR. SELECTOR TO NAV. REC.
- AMBIGUITY METER
- AMBIGUITY METER
- OMNI BEARING SEL. STATOR } TWISTED
- OMNI BEARING SEL. STATOR } PAIR
- OMNI BEARING SEL. STATOR } TWISTED
- OMNI BEARING SEL. STATOR } PAIR
- OMNI BEARING SEL. ROTOR } TWISTED
- OMNI BEARING SEL. ROTOR } PAIR

CABLE E DEVIATION INDICATOR TO GLIDE PATH REC.
- GLIDE PATH POINTER
- GLIDE PATH POINTER
- GLIDE PATH FLAG ALARM
- GLIDE PATH FLAG ALARM

CABLE F FREQUENCY SELECTOR TO GLIDE PATH REC.
- CHANNEL SELECTOR WIRES (10)

CABLE H NAV. REC. TO AUDIO MIXING SYSTEM
- AUDIO LINE *

CABLE J RMI TO ADF
- ADF AUTOSYN STATOR
- ADF AUTOSYN STATOR
- ADF AUTOSYN STATOR & ROTOR COMMON
- ADF AUTOSYN ROTOR

CABLE K ACCESSORY UNIT TO RMI
- VHF ADF AUTOSYN STATOR
- VHF ADF AUTOSYN STATOR
- 26 V 400 CYCLE-ROTOR
- GROUND
- MOTOR PHASE
- MOTOR PHASE
- MAGNETIC FOLLOW UP SIGNAL

CABLE L ACCESSORY UNIT TO RMI
- AUTOSYN STATOR
- AUTOSYN STATOR

NOTES:
1. No provisions shown for RMI or deviation Ind. Switching
2. No provisions shown for ON-OFF switching
3. Automatic Radio Flight Control (for landing or enroute flying) Connects to receiver output circuits in parallel with deviation indicators.
4. Accessory unit to contain:
   - Omni bearing indicators
   - Dynamotors
   - Space available for 3 RMI dial drive servo amplifiers if required
5. 400 cycle must be from same source as gyrosyn compass
6. Wires marked with * tenatively shielded
7. No wiring shown for instrument lighting
8. Antenna transfer wire open circuit below 122 mc. energised (+26 V) 122 MC. and above.

Figure 2-2 Navigation System, Full Instrumentation

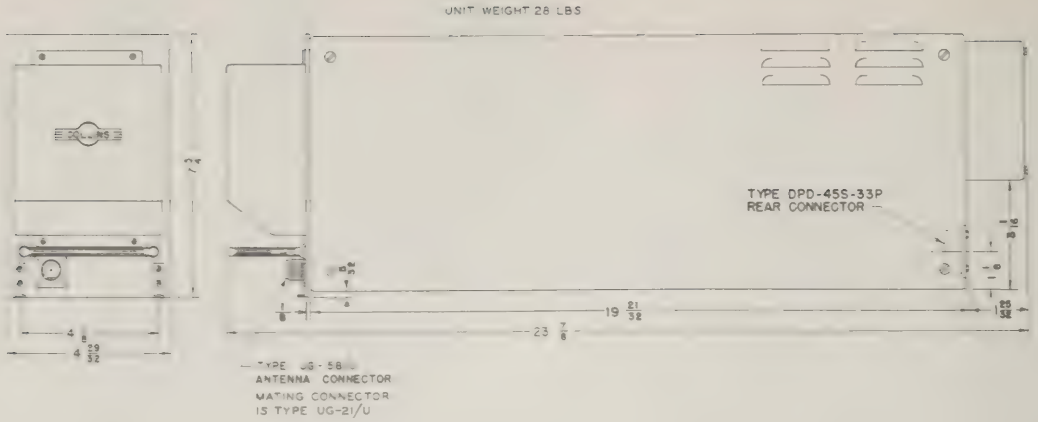


Figure 2-3 51R Navigation and Communication Receiver (Outline)

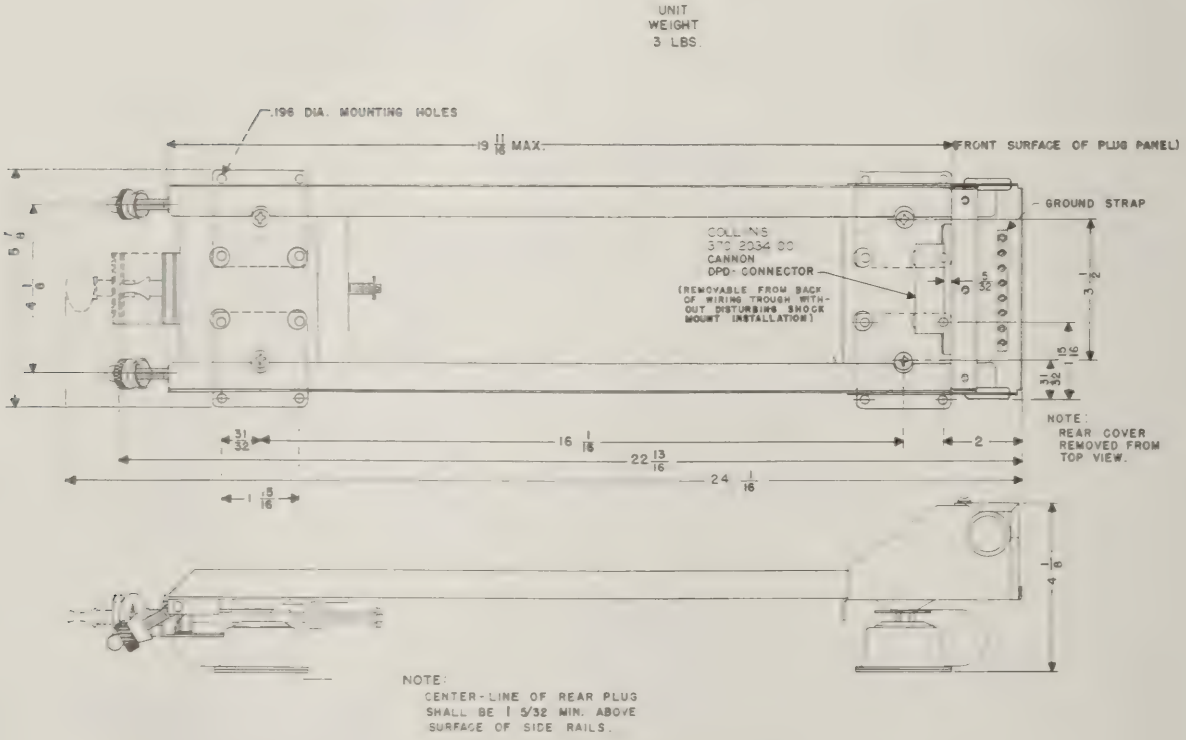


Figure 2-4 Shockmount For Receiver or Accessory Unit

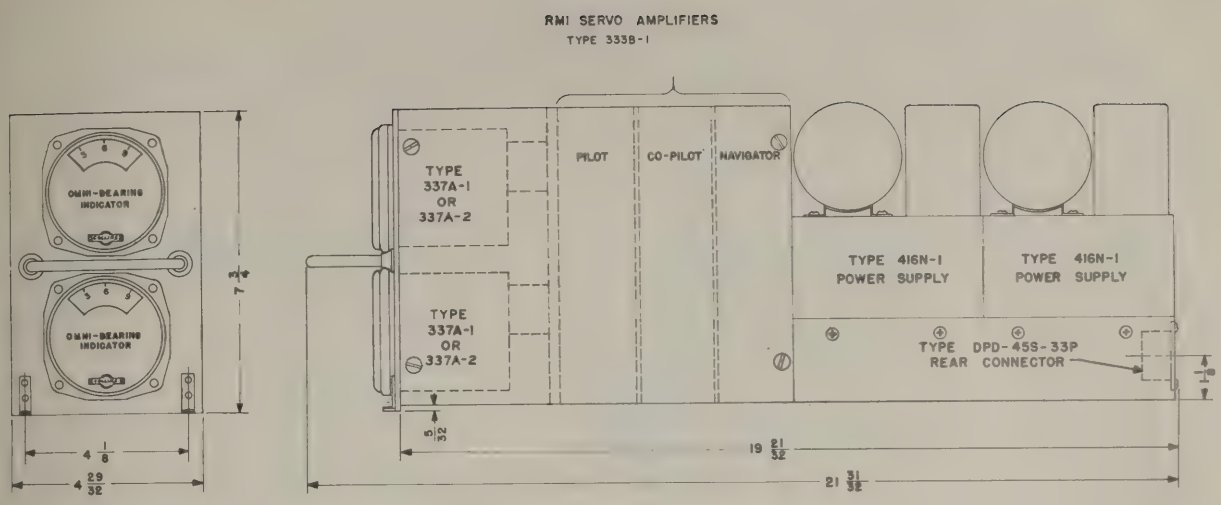


Figure 2-5 351A Accessory Unit

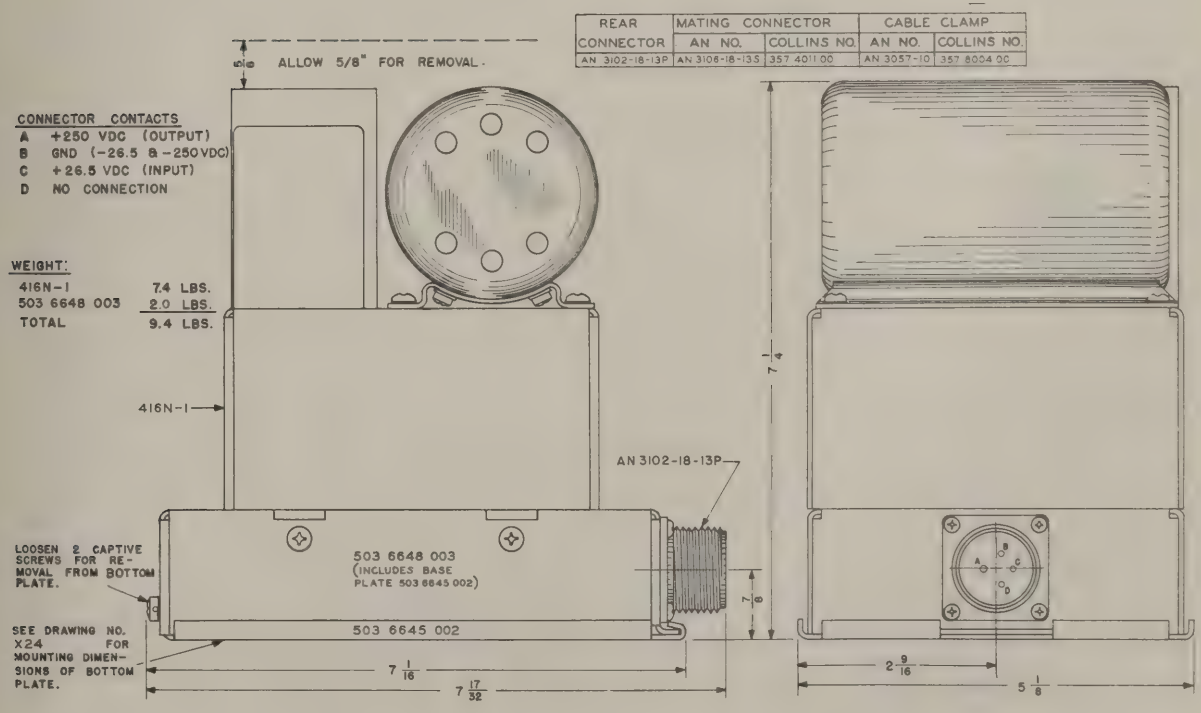


Figure 2-6 416N-1 Power Supply and 503 6648 003 Mounting Base

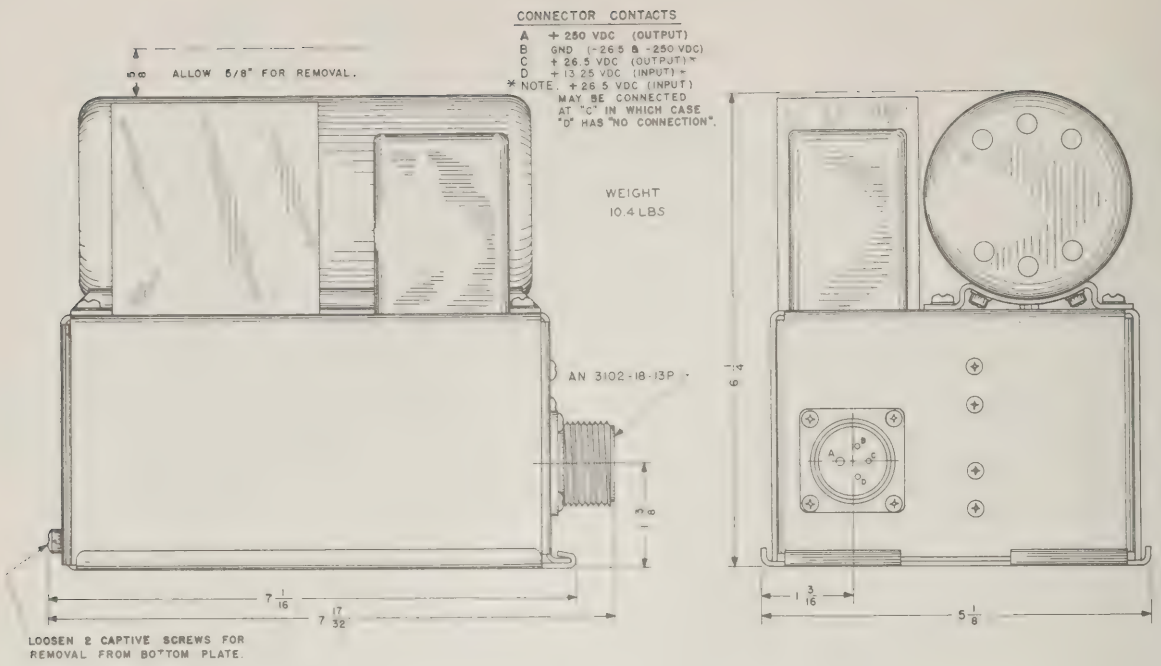

CONNECTOR CONTACTS
A +250 VDC (OUTPUT)
B GND (-26.5 & -250 VDC)
C +26.5 VDC (OUTPUT)*
D +13.25 VDC (INPUT)*
* NOTE. +26.5 VDC (INPUT) MAY BE CONNECTED AT "C" IN WHICH CASE "D" HAS "NO CONNECTION".
ALLOW 5/8" FOR REMOVAL.
WEIGHT 10.4 LBS
AN 3102-18-13P
7 1/16
7 17/32
LOOSEN 2 CAPTIVE SCREWS FOR REMOVAL FROM BOTTOM PLATE.
1 3/16
5 1/8

Figure 2-7 416N-2 Power Supply

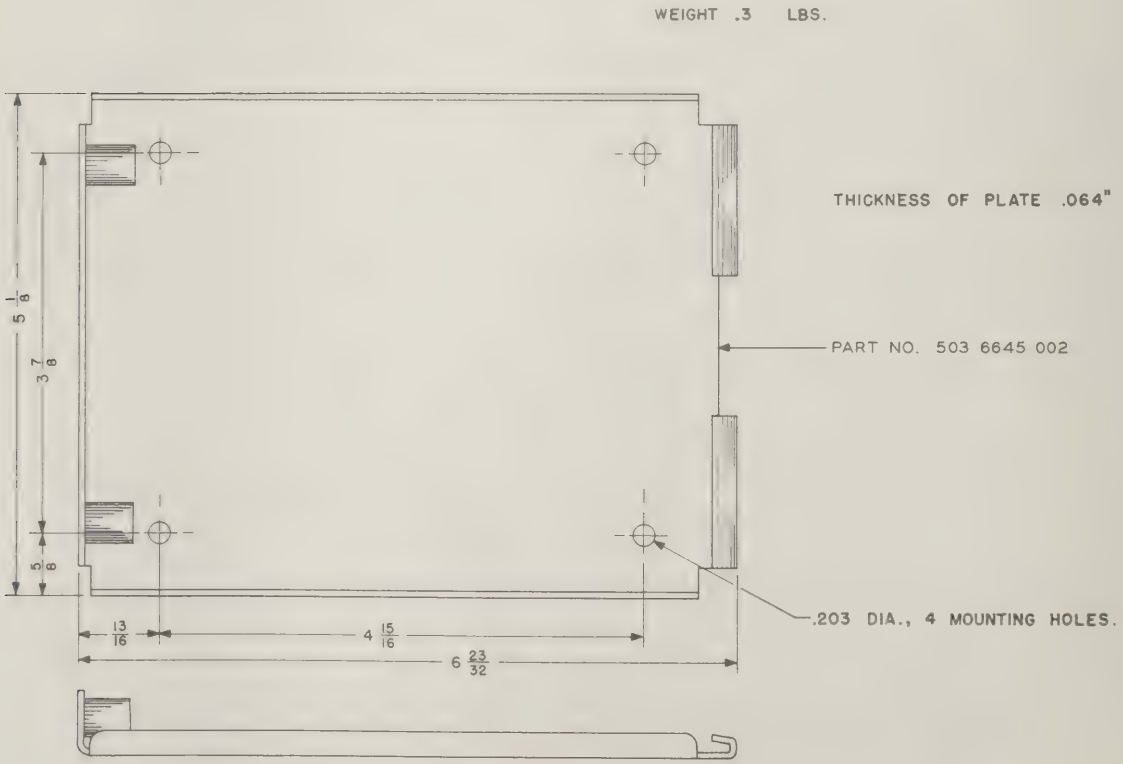


Figure 2-8 Bottom Plate for Mounting Base for 416N-2 Power Unit

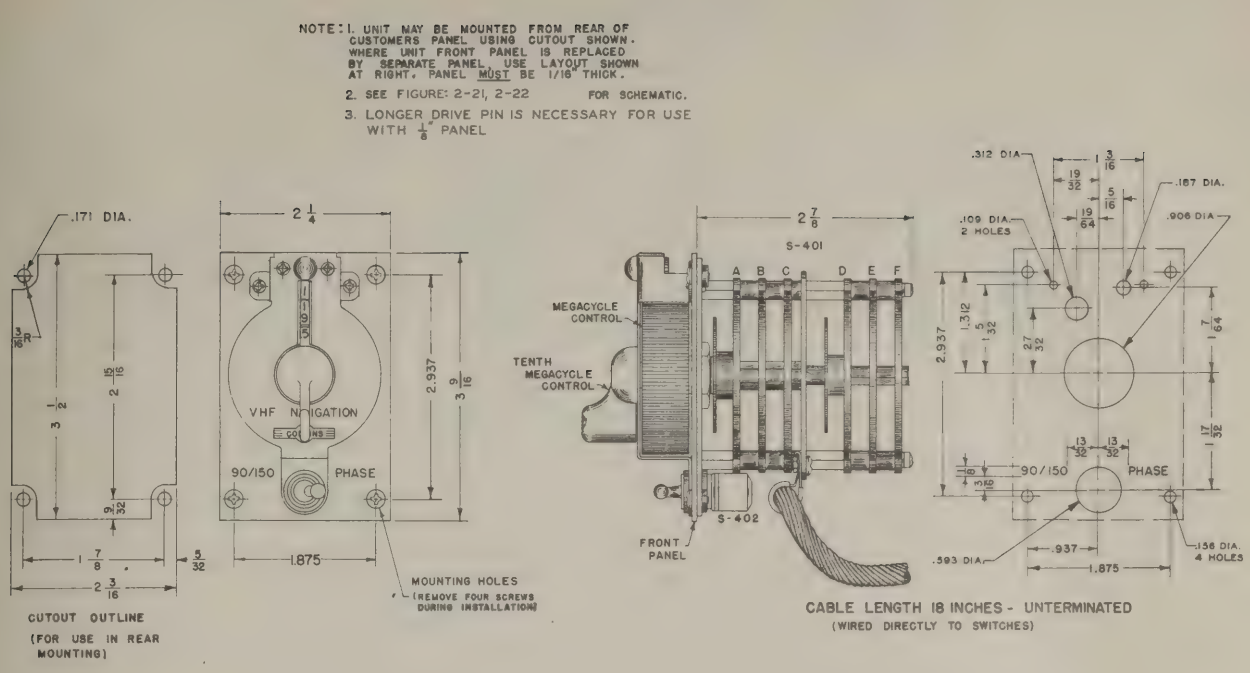

NOTE: 1. UNIT MAY BE MOUNTED FROM REAR OF CUSTOMERS PANEL USING CUTOUT SHOWN. WHERE UNIT FRONT PANEL IS REPLACED BY SEPARATE PANEL USE LAYOUT SHOWN AT RIGHT. PANEL MUST BE 1/16" THICK.
2. SEE FIGURE: 2-21, 2-22 FOR SCHEMATIC.
3. LONGER DRIVE PIN IS NECESSARY FOR USE WITH 1/8" PANEL
.171 DIA.
VHF NAVIGATION
90/150
PHASE
1.875
MOUNTING HOLES (REMOVE FOUR SCREWS DURING INSTALLATION)
CUTOUT OUTLINE (FOR USE IN REAR MOUNTING)
S-401
MEGACYCLE CONTROL
TENTH MEGACYCLE CONTROL
S-402
FRONT PANEL
.312 DIA
.187 DIA.
.109 DIA. 2 HOLES
.906 DIA
.593 DIA
.937
.156 DIA. 4 HOLES
CABLE LENGTH 18 INCHES - UNTERMINATED
(WIRED DIRECTLY TO SWITCHES)

Figure 2-9 314U-1, 314U-5 Frequency Control Unit

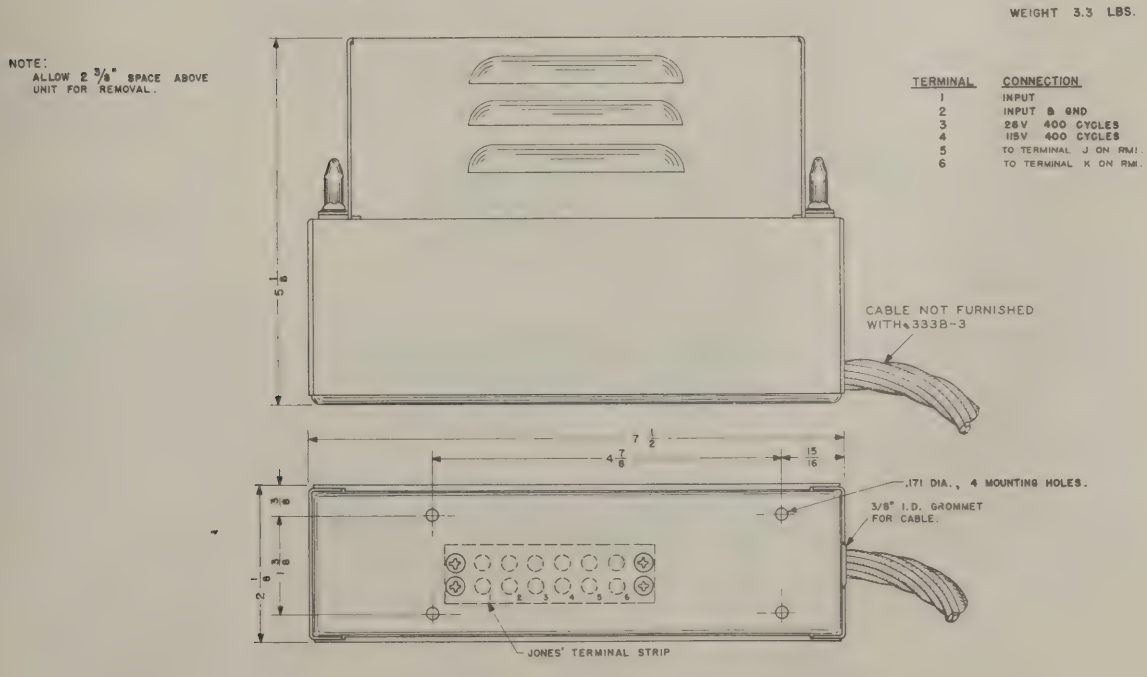
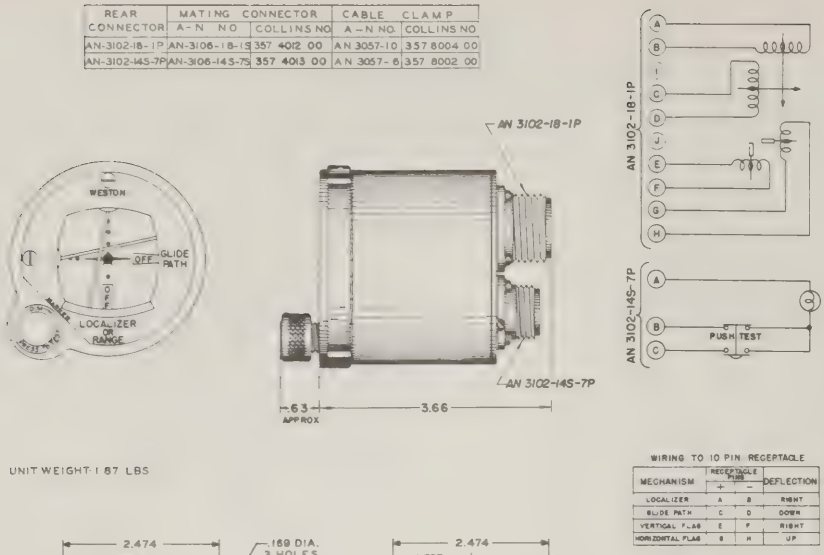

WEIGHT 3.3 LBS.
NOTE: ALLOW 2 3/8" SPACE ABOVE UNIT FOR REMOVAL.
TERMINAL CONNECTION
1 INPUT
2 INPUT B GND
3 26V 400 CYCLES
4 115V 400 CYCLES
5 TO TERMINAL J ON RMI.
6 TO TERMINAL K ON RMI.
CABLE NOT FURNISHED WITH 3338-3
.171 DIA., 4 MOUNTING HOLES.
3/8" I.D. GROMMET FOR CABLE.
JONES' TERMINAL STRIP

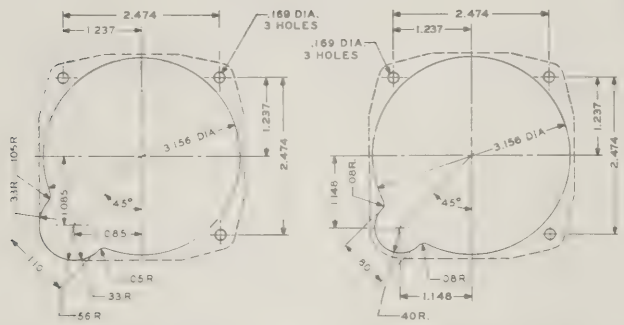
Figure 2-10 333B Servoamplifier (Outline)

REAR CONNECTOR	MATING CONNECTOR		CABLE CLAMP	
	A-N NO	COLLINS NO	A-N NO	COLLINS NO
AN-3102-18-1P	AN-3106-18-1S	357 4012 00	AN 3057-10	357 8004 00
AN-3102-14S-7P	AN-3106-14S-7S	357 4013 00	AN 3057-6	357 8002 00



WIRING TO 10 PIN RECEPTACLE

MECHANISM	RECEPTACLE PINS +	RECEPTACLE PINS −	DEFLECTION
LOCALIZER	A	B	RIGHT
GLIDE PATH	C	D	DOWN
VERTICAL FLAG	E	F	RIGHT
HORIZONTAL FLAG	G	H	UP



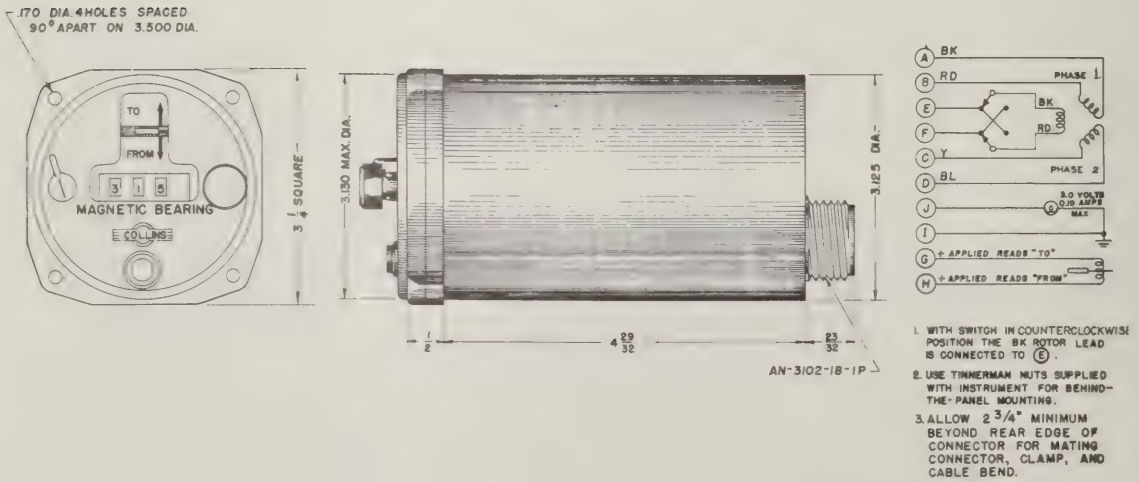
NOTE:
ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF AN 3102-18-1P CONNECTOR FOR MATING CONNECTOR CLAMP & CABLE BEND

(A) REAR OF PANEL MOUNTING

(B) FRONT OF PANEL MOUNTING

Figure 2-11 Deviation Indicator (Weston Model 888, Type 3) (U.S. Air Forces Type ID-48AF/ARN)

REAR CONNECTOR	MATING CONNECTOR		CABLE CLAMP	
	A-N NO.	COLLINS NO.	A-N NO.	COLLINS NO.
AN3102-18-1P	AN3106-18-1S	357 4012 00	AN3057-10	357 8004 00

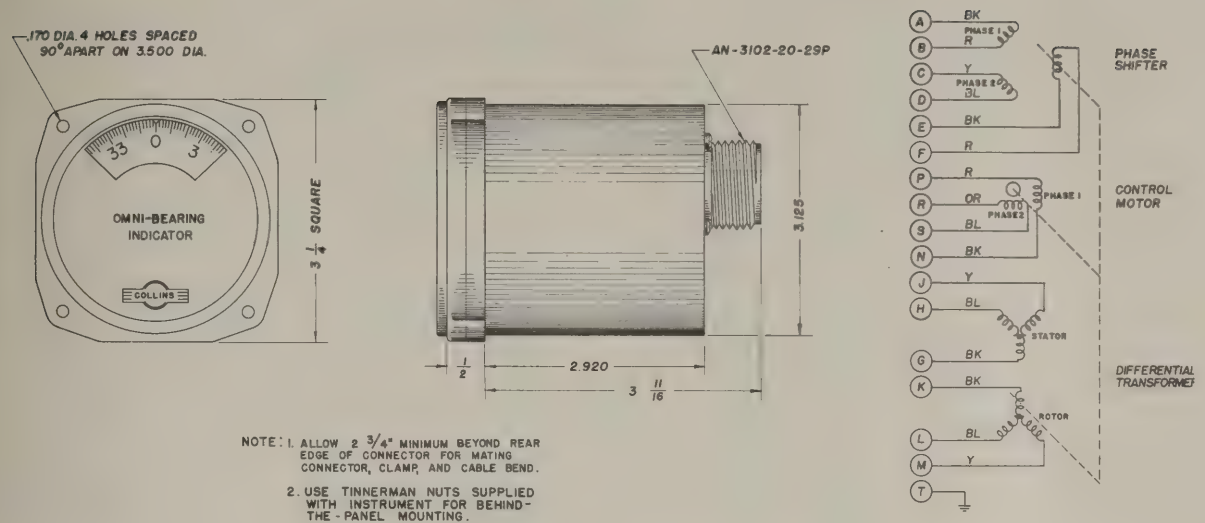


1. WITH SWITCH IN COUNTERCLOCKWISE POSITION THE BK ROTOR LEAD IS CONNECTED TO (E).
2. USE TINNERMAN NUTS SUPPLIED WITH INSTRUMENT FOR BEHIND-THE-PANEL MOUNTING.
3. ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

Figure 2-12 336A-1 or A-2 Omni-Bearing Selector

UNIT WEIGHT 2.6 LBS.

REAR CONNECTOR	MATING CONNECTOR A-N NO.	MATING CONNECTOR COLLINS NO.	CABLE CLAMP A-N NO.	CABLE CLAMP COLLINS NO.
AN-3102-20-29P	AN-3106-20-29S	357 4004 00	AN-3057-12	357 8005 00



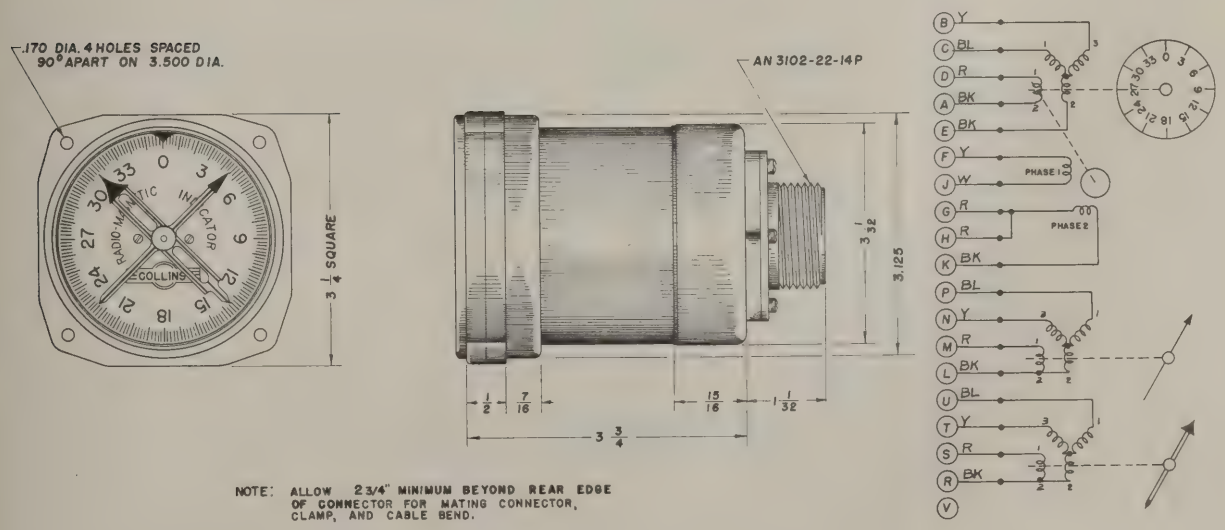
NOTE: 1. ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

2. USE TINNERMAN NUTS SUPPLIED WITH INSTRUMENT FOR BEHIND-THE-PANEL MOUNTING.

Figure 2-13 337A-1 or A-2 Omni-Bearing Indicator

UNIT WEIGHT 2 LBS.

REAR CONNECTOR	MATING CONNECTOR A-N NO.	MATING CONNECTOR COLLINS No	CABLE CLAMP A-N NO.	CABLE CLAMP COLLINS NO.
AN-3102-22-14P	AN-3106-22-14S	357 4005 00	AN-3057-12	357 8005 00



NOTE: ALLOW 2 3/4" MINIMUM BEYOND REAR EDGE OF CONNECTOR FOR MATING CONNECTOR, CLAMP, AND CABLE BEND.

Figure 2-14 332C-1 Radio Magnetic Indicator

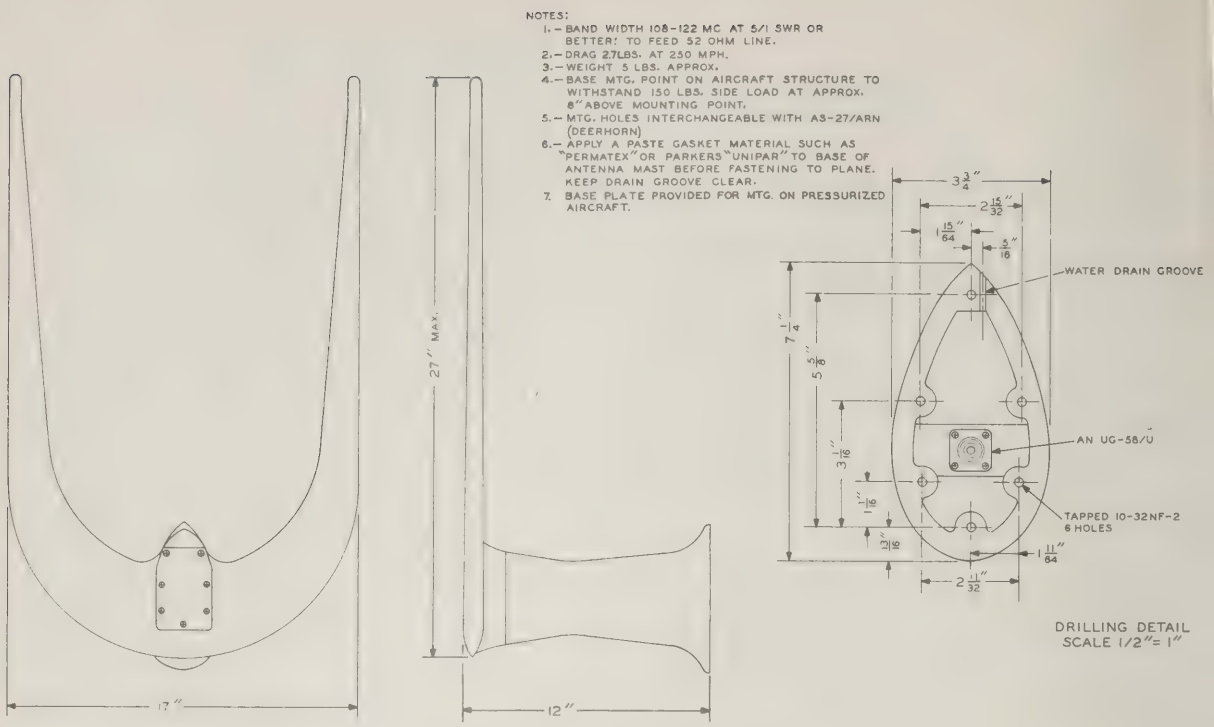

NOTES:
1. – BAND WIDTH 108-122 MC AT 5/1 SWR OR BETTER: TO FEED 52 OHM LINE.
2. – DRAG 27LBS. AT 250 MPH.
3. – WEIGHT 5 LBS. APPROX.
4. – BASE MTG. POINT ON AIRCRAFT STRUCTURE TO WITHSTAND 150 LBS. SIDE LOAD AT APPROX. 8" ABOVE MOUNTING POINT.
5. – MTG. HOLES INTERCHANGEABLE WITH AS-27/ARN (DEERHORN)
6. – APPLY A PASTE GASKET MATERIAL SUCH AS "PERMATEX" OR PARKERS "UNIPAR" TO BASE OF ANTENNA MAST BEFORE FASTENING TO PLANE. KEEP DRAIN GROOVE CLEAR.
7. BASE PLATE PROVIDED FOR MTG. ON PRESSURIZED AIRCRAFT.
27" MAX.
17"
12"
WATER DRAIN GROOVE
AN UG-58/U
TAPPED 10-32NF-2 6 HOLES
DRILLING DETAIL
SCALE 1/2" = 1"

Figure 2-15 37J Antenna

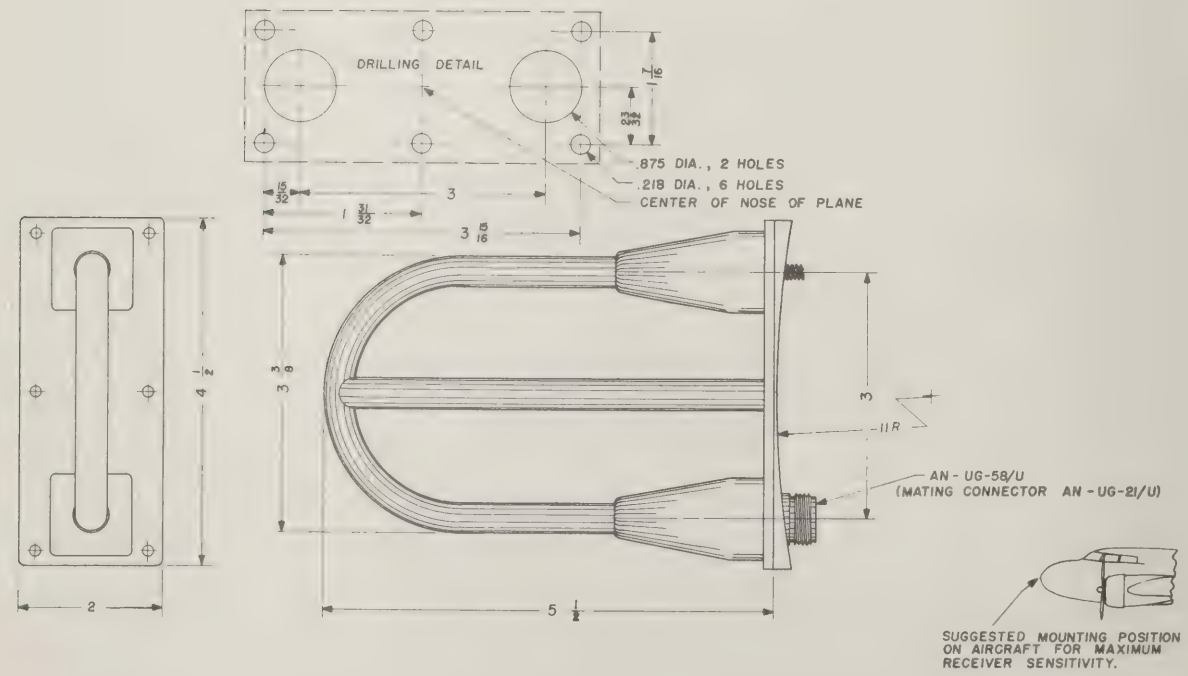

DRILLING DETAIL
.875 DIA., 2 HOLES
.218 DIA., 6 HOLES
CENTER OF NOSE OF PLANE
AN-UG-58/U
(MATING CONNECTOR AN-UG-21/U)
SUGGESTED MOUNTING POSITION ON AIRCRAFT FOR MAXIMUM RECEIVER SENSITIVITY.

Figure 2-16 Type 37P-1 Glide Slope Antenna

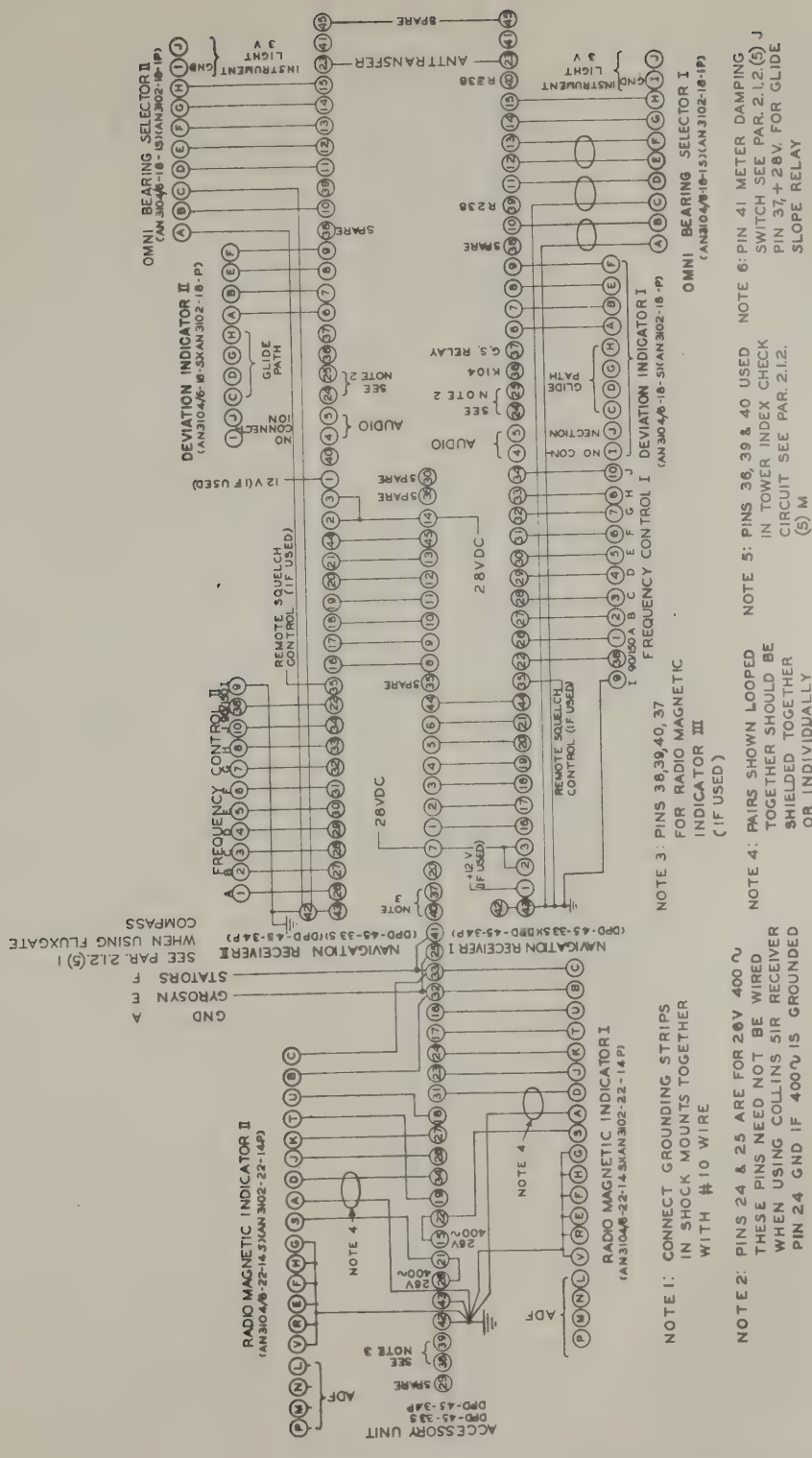

OMNI BEARING SELECTOR II
(AN 3104/8-18-1S)(AN 3102-18-1P)
INSTRUMENT LIGHT 3 V
ANT TRANSFER
SPARE
DEVIATION INDICATOR II
(AN 3104/8-18-3S)(AN 3102-18-1P)
GLIDE PATH
NO CONNECTION
AUDIO
SEE NOTE 2
12 V (IF USED)
REMOTE SQUELCH CONTROL (IF USED)
28VDC
FREQUENCY CONTROL I
(AN 3104/8-18-3S)(AN 3102-18-1P)
NAVIGATION RECEIVER II
(DPD-43-33 S)(DPD-43-34P)
SEE PAR. 2.12.(5) I WHEN USING FLUXGATE COMPASS
GND A
GYROSYN STATORS E F
NAVIGATION RECEIVER I
(DPD-43-33S)(DPD-43-34P)
NOTE 3
(12 V (IF USED)
R238
G.S. RELAY K104
NOTE 2
NO CONNECTION
DEVIATION INDICATOR I
(AN 3104/8-18-3S)(AN 3102-18-1P)
OMNI BEARING SELECTOR I
(AN 3104/8-18-1S)(AN 3102-18-1P)
RADIO MAGNETIC INDICATOR II
(AN 3104/8-22-14S)(AN 3102-22-14P)
ADF
NOTE 4
400~
26V
ACCESSORY UNIT
DPD-43-33S
DPD-43-34P
RADIO MAGNETIC INDICATOR I
(AN 3104/8-22-14S)(AN 3102-22-14P)
NOTE 3 : PINS 38,39,40,37 FOR RADIO MAGNETIC INDICATOR III (IF USED)
NOTE 5: PINS 36, 39 & 40 USED IN TOWER INDEX CHECK CIRCUIT SEE PAR. 2.12. (5) M
NOTE 6: PIN 41 METER DAMPING SWITCH SEE PAR. 2.12.(5) J PIN 37, + 28V. FOR GLIDE SLOPE RELAY
NOTE 1: CONNECT GROUNDING STRIPS IN SHOCK MOUNTS TOGETHER WITH #10 WIRE
NOTE 2: PINS 24 & 25 ARE FOR 26V 400~ THESE PINS NEED NOT BE WIRED WHEN USING COLLINS 51R RECEIVER PIN 24 GND IF 400~ IS GROUNDED
NOTE 4: PAIRS SHOWN LOOPED TOGETHER SHOULD BE SHIELDED TOGETHER OR INDIVIDUALLY

Figure 2-17 VHF Navigation System Wiring Details

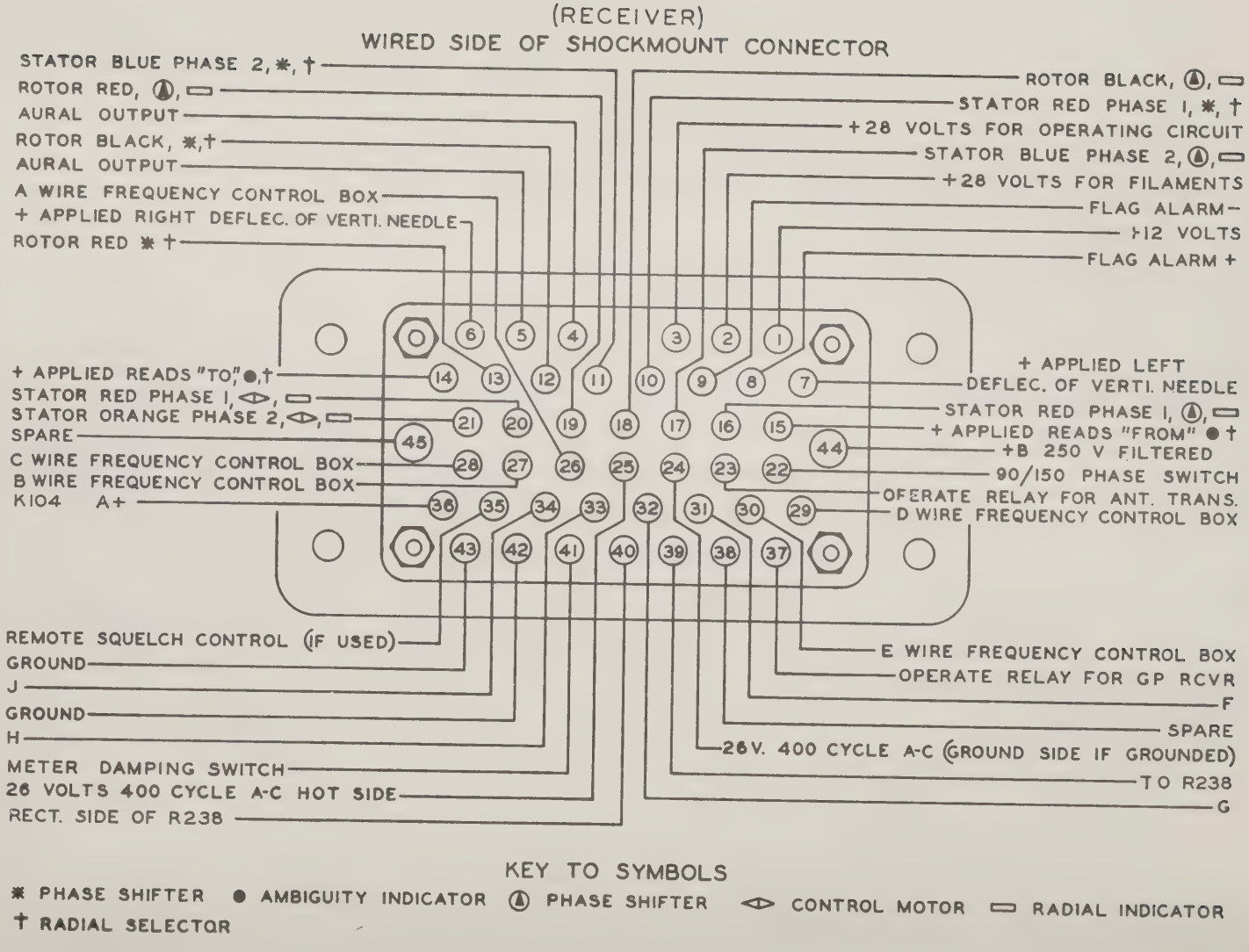

(RECEIVER)
WIRED SIDE OF SHOCKMOUNT CONNECTOR
STATOR BLUE PHASE 2, ✱, †
ROTOR RED, ⓐ, ▭
AURAL OUTPUT
ROTOR BLACK, ✱, †
AURAL OUTPUT
A WIRE FREQUENCY CONTROL BOX
+ APPLIED RIGHT DEFLEC. OF VERTI. NEEDLE
ROTOR RED ✱ †
+ APPLIED READS "TO", ●, †
STATOR RED PHASE I, ◇, ▭
STATOR ORANGE PHASE 2, ◇, ▭
SPARE
C WIRE FREQUENCY CONTROL BOX
B WIRE FREQUENCY CONTROL BOX
K104 A+
REMOTE SQUELCH CONTROL (IF USED)
GROUND
J
GROUND
H
METER DAMPING SWITCH
26 VOLTS 400 CYCLE A-C HOT SIDE
RECT. SIDE OF R238
ROTOR BLACK, ⓐ, ▭
STATOR RED PHASE I, ✱, †
+28 VOLTS FOR OPERATING CIRCUIT
STATOR BLUE PHASE 2, ⓐ, ▭
+28 VOLTS FOR FILAMENTS
FLAG ALARM −
+12 VOLTS
FLAG ALARM +
+ APPLIED LEFT DEFLEC. OF VERTI. NEEDLE
STATOR RED PHASE I, ⓐ, ▭
+ APPLIED READS "FROM" ● †
+B 250 V FILTERED
90/150 PHASE SWITCH
OPERATE RELAY FOR ANT. TRANS.
D WIRE FREQUENCY CONTROL BOX
E WIRE FREQUENCY CONTROL BOX
OPERATE RELAY FOR GP RCVR
F
SPARE
26V. 400 CYCLE A-C (GROUND SIDE IF GROUNDED)
TO R238
G
KEY TO SYMBOLS
✱ PHASE SHIFTER ● AMBIGUITY INDICATOR ⓐ PHASE SHIFTER ◇ CONTROL MOTOR ▭ RADIAL INDICATOR
† RADIAL SELECTOR

Figure 2-18 Receiver Shock Mount Connector (Wire Connections)

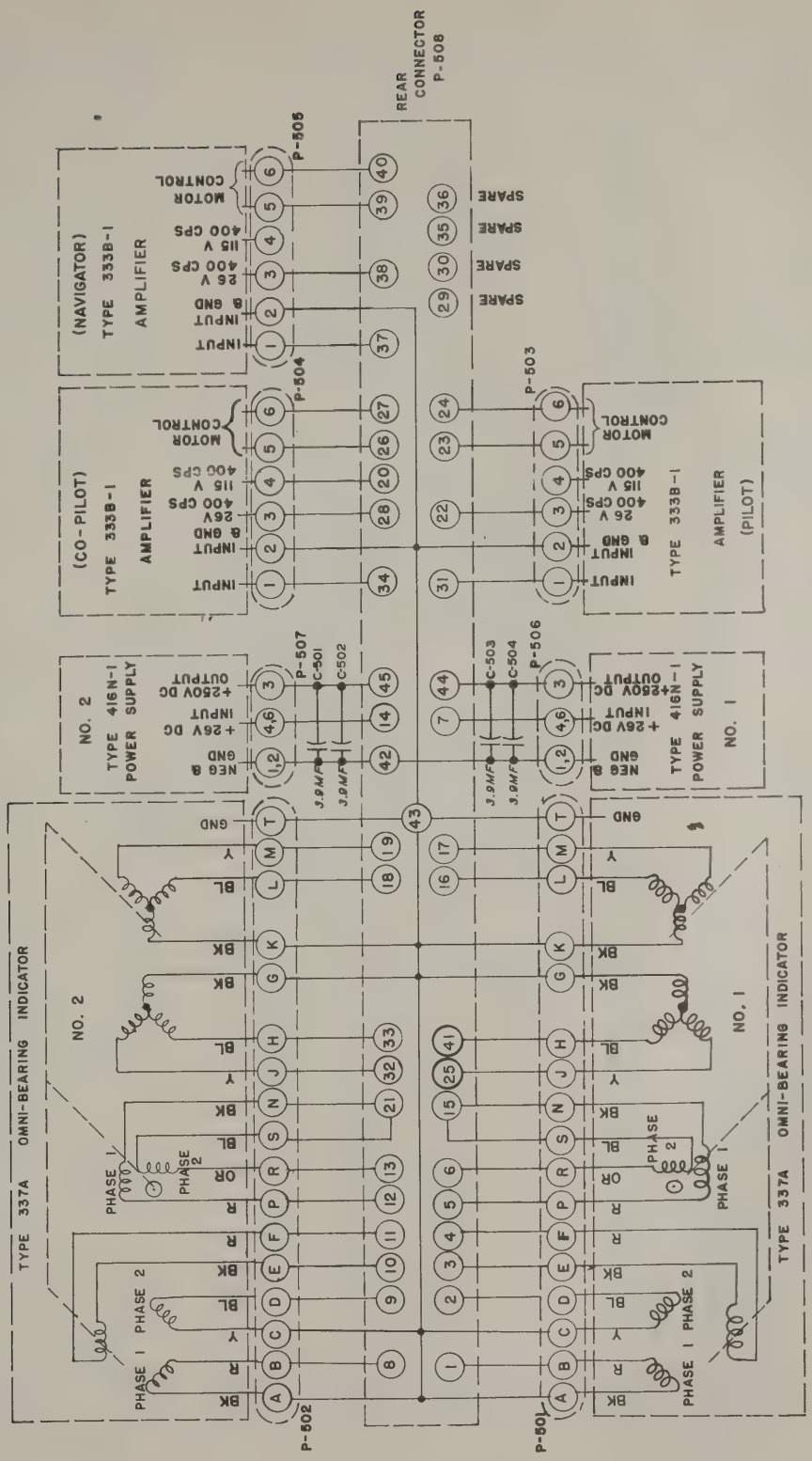


Figure 2-19 351A Accessory Unit, Connection Diagram

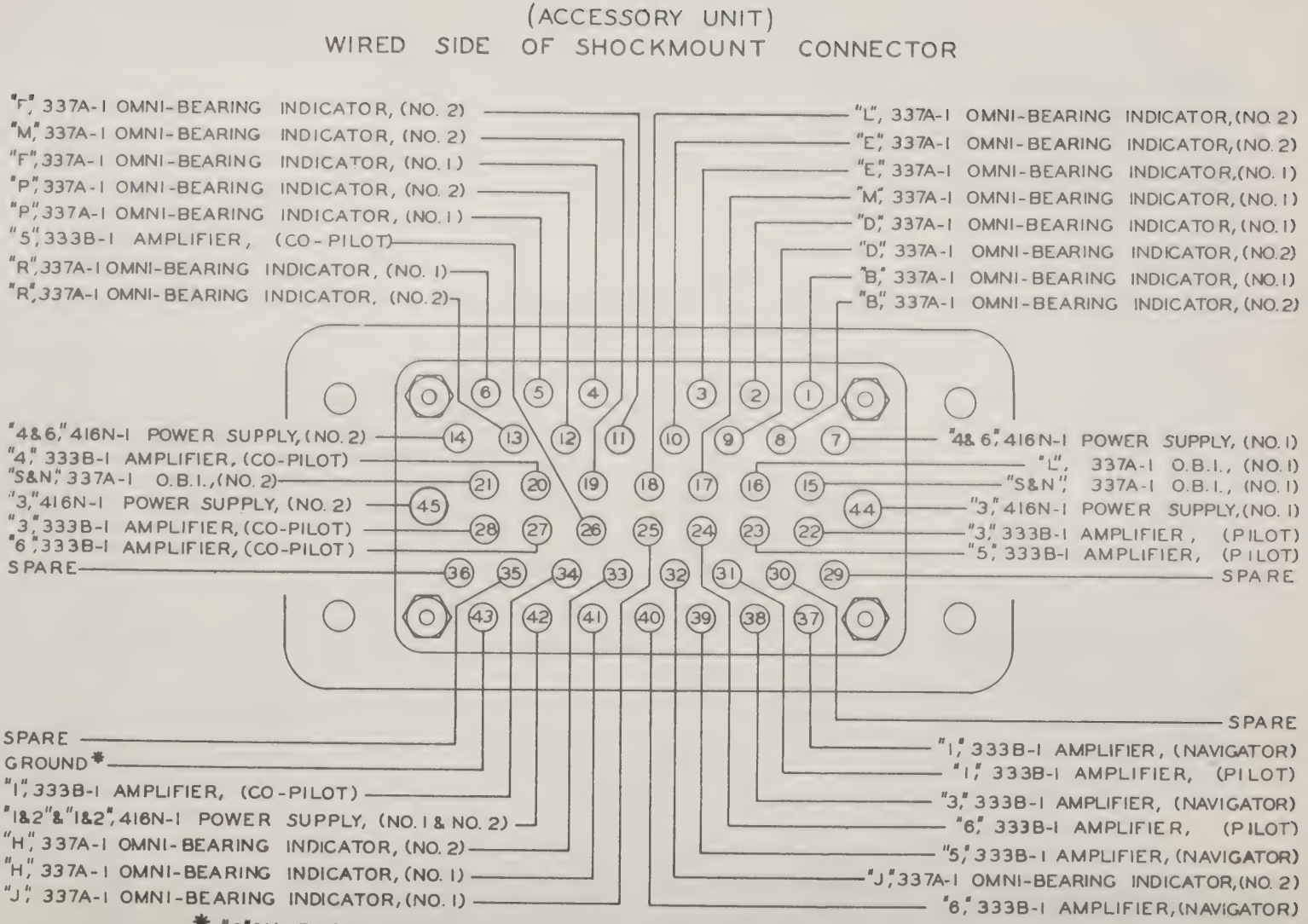

(ACCESSORY UNIT)
WIRED SIDE OF SHOCKMOUNT CONNECTOR
"F", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"M", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"F", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"P", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"P", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"5", 333B-1 AMPLIFIER, (CO-PILOT)
"R", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"R", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"L", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"E", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"E", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"M", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"D", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"D", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"B", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"B", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"4 & 6", 416N-1 POWER SUPPLY, (NO. 2)
"4", 333B-1 AMPLIFIER, (CO-PILOT)
"S&N", 337A-1 O.B.I., (NO. 2)
"3", 416N-1 POWER SUPPLY, (NO. 2)
"3", 333B-1 AMPLIFIER, (CO-PILOT)
"6", 333B-1 AMPLIFIER, (CO-PILOT)
SPARE
"4 & 6", 416N-1 POWER SUPPLY, (NO. 1)
"L", 337A-1 O.B.I., (NO. 1)
"S&N", 337A-1 O.B.I., (NO. 1)
"3", 416N-1 POWER SUPPLY, (NO. 1)
"3", 333B-1 AMPLIFIER, (PILOT)
"5", 333B-1 AMPLIFIER, (PILOT)
SPARE
SPARE
GROUND*
"1", 333B-1 AMPLIFIER, (CO-PILOT)
"1&2" & "1&2", 416N-1 POWER SUPPLY, (NO. 1 & NO. 2)
"H", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"H", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
"J", 337A-1 OMNI-BEARING INDICATOR, (NO. 1)
SPARE
"1", 333B-1 AMPLIFIER, (NAVIGATOR)
"1", 333B-1 AMPLIFIER, (PILOT)
"3", 333B-1 AMPLIFIER, (NAVIGATOR)
"6", 333B-1 AMPLIFIER, (PILOT)
"5", 333B-1 AMPLIFIER, (NAVIGATOR)
"J", 337A-1 OMNI-BEARING INDICATOR, (NO. 2)
"6", 333B-1 AMPLIFIER, (NAVIGATOR)
* "2" ON PILOT, CO-PILOT, & NAVIGATOR, 333B-1 AMPLIFIER
"A & C", "G & K", "T" } ON NO. 1, & NO. 2, OMNI-BEARING INDICATOR

Figure 2-20 Accessory Unit Shock Mount Connectors (Wire Connections)

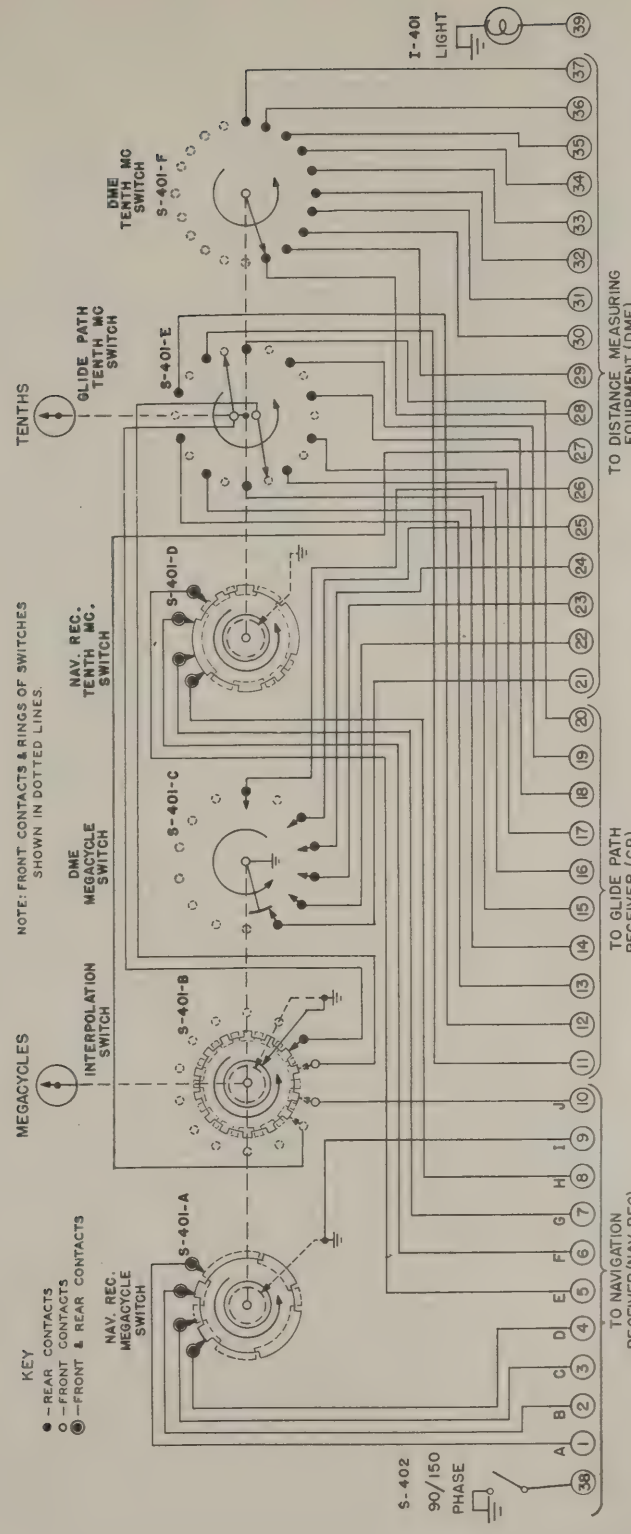


Figure 2-21 314U-1 Frequency Control Unit, Schematic Diagram (Provision for up to 10 channel Glide Slope)

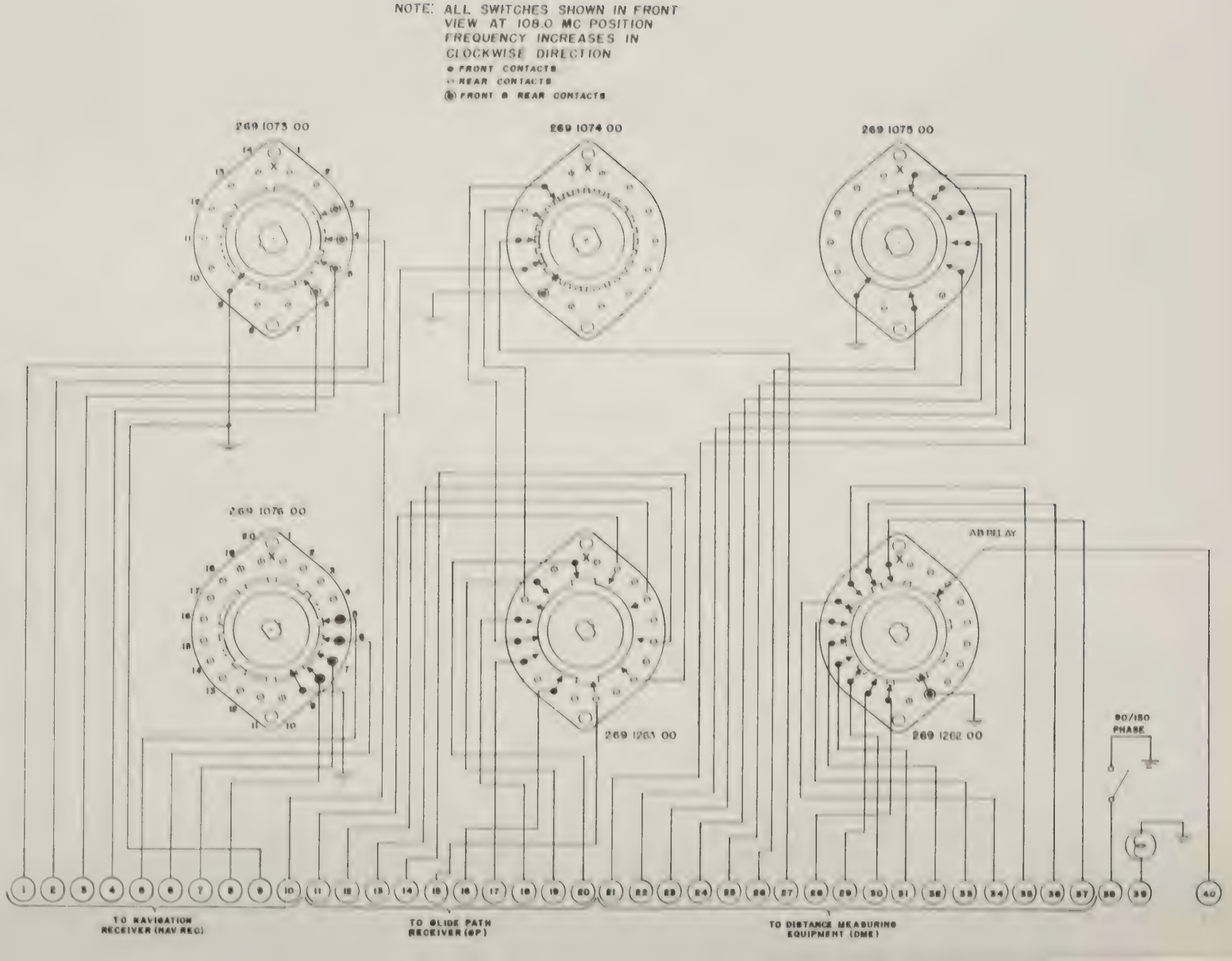

NOTE: ALL SWITCHES SHOWN IN FRONT VIEW AT 108.0 MC POSITION FREQUENCY INCREASES IN CLOCKWISE DIRECTION
● FRONT CONTACTS
○ REAR CONTACTS
◉ FRONT & REAR CONTACTS
269 1073 00
269 1074 00
269 1075 00
269 1076 00
269 1263 00
269 1262 00
AB RELAY
90/180 PHASE
TO NAVIGATION RECEIVER (NAV REC)
TO GLIDE PATH RECEIVER (GP)
TO DISTANCE MEASURING EQUIPMENT (DME)

Figure 2-22 31A1-5 Frequency Control Unit, Schematic Diagram (Provision for 20 Channel Glide Slope)

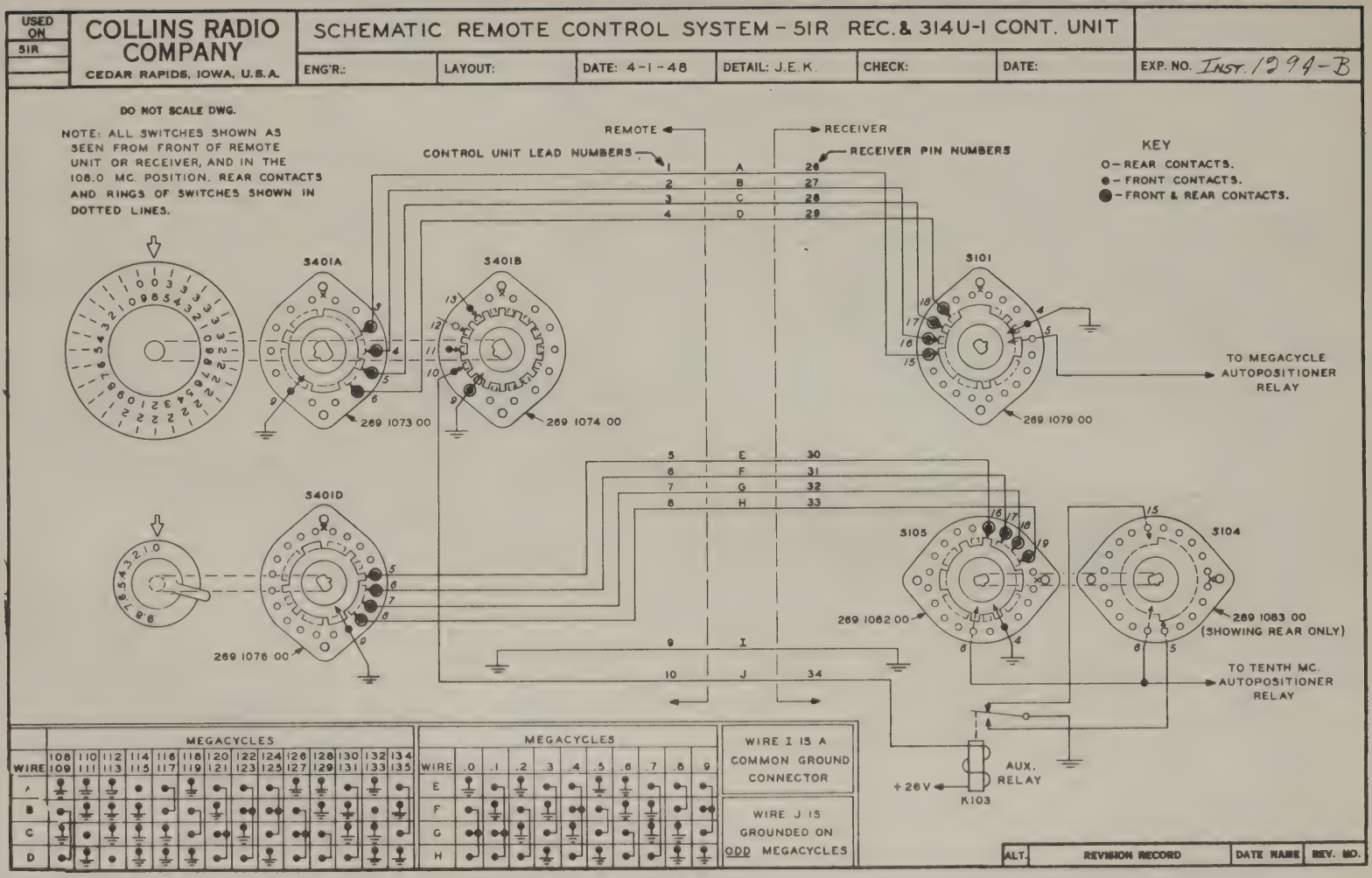


Figure 2-23 Schematic Remote Control System for 51R Receiver

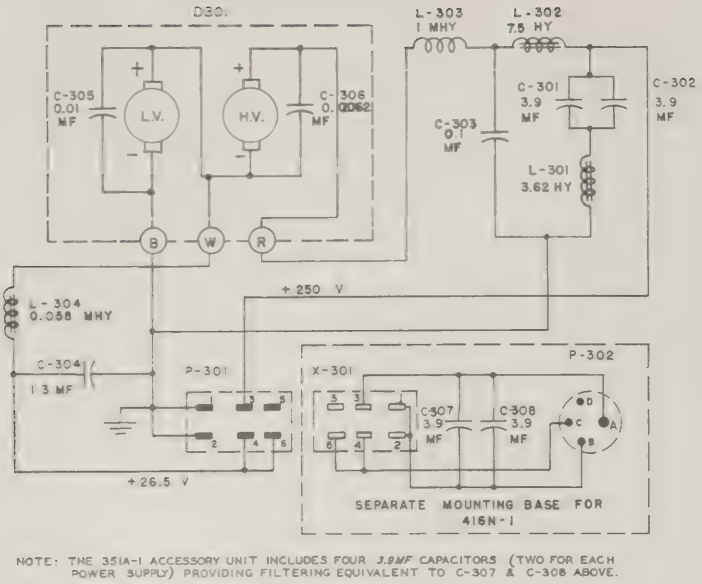


Figure 2-24 416N-1 Power Supply Schematic

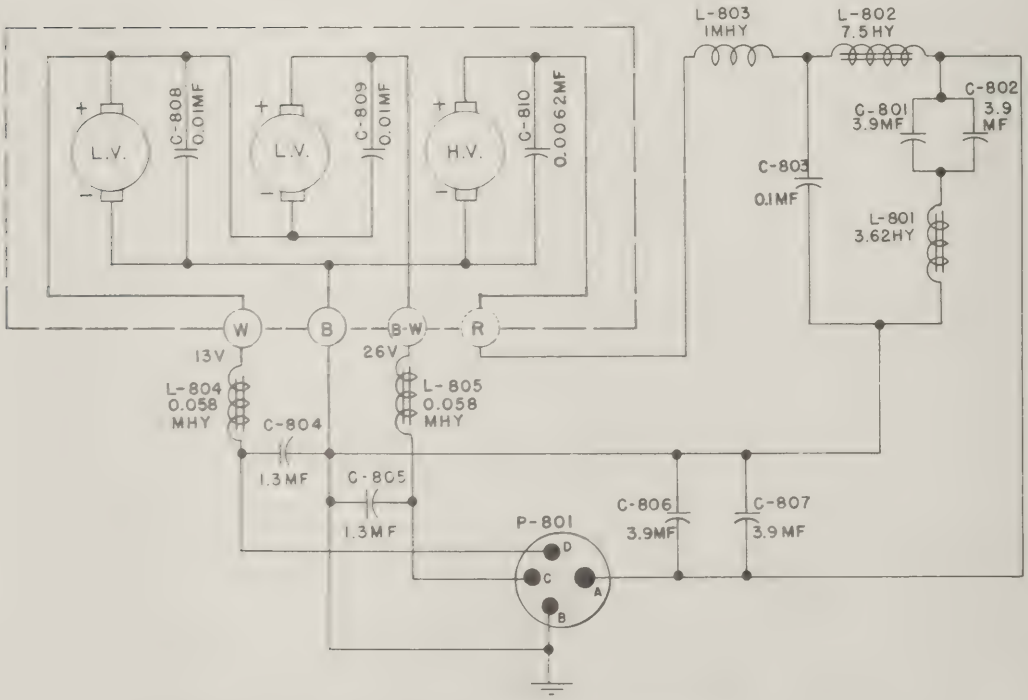


Figure 2-25 416N-2 Power Supply Schematic

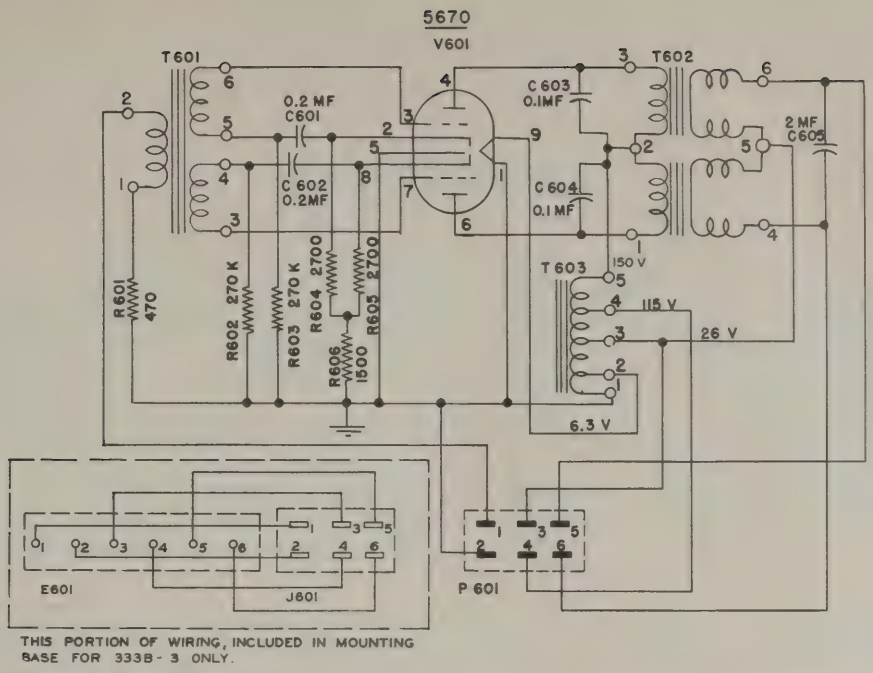


Figure 2-26 333B-1 and 333B-3 Servo Amplifier Schematic

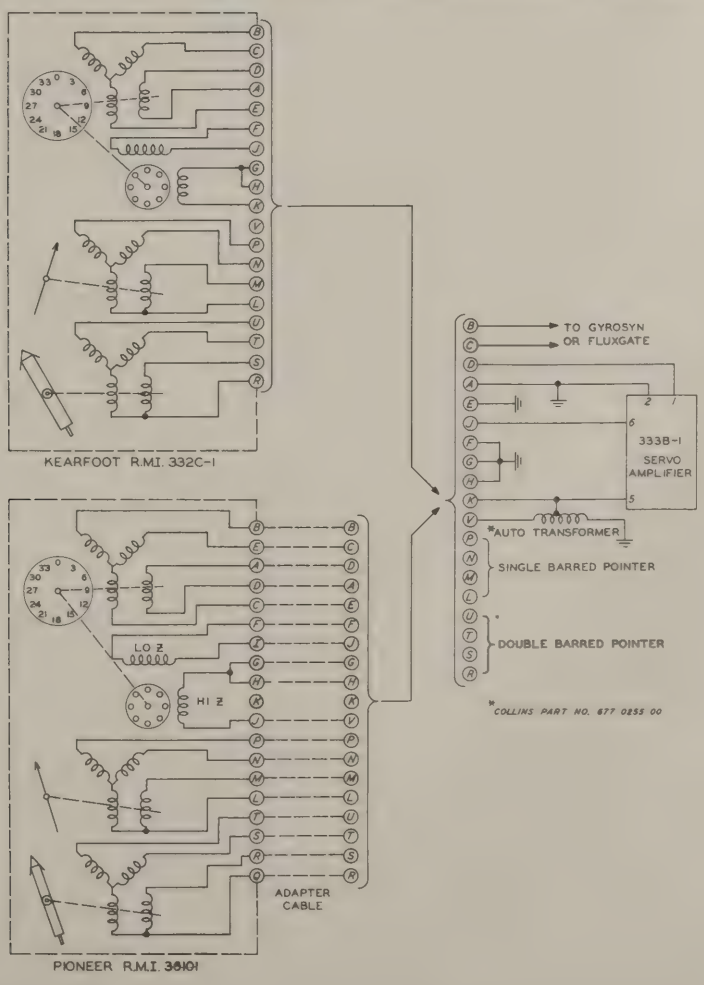


Figure 2-27 Kearfoot and Pioneer RMI Connections

SECTION 3

ADJUSTMENT AND OPERATION

The adjustment and operation of the Collins 51R Navigation Receiver and accessories is comparatively simple. There are no adjustments that need be performed after the equipment has been installed. A number of checks can be made to determine if the system is operating properly while the equipment is in the plane. These equipment checks will be outlined in the maintenance section of this instruction book. If these checks indicate that the equipment is not operating entirely satisfactorily, it will usually be necessary to remove the equipment from the plane and thus the adjustment becomes a maintenance problem. Detailed circuit alignment, voltage, resistance and phase angle measurements and trouble shooting procedures will be included in Section 5.

Operation of the equipment consists of selecting the frequency to be received with the frequency control unit and selecting the track with the omni-bearing selector.

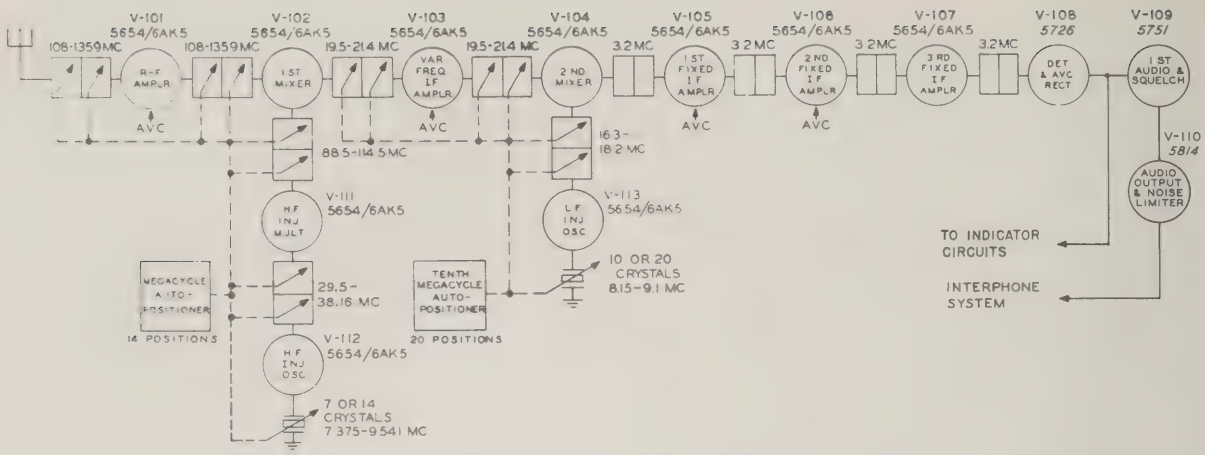


Figure 4-1 Block Diagram of 51R-2 R-F and Audio Circuits

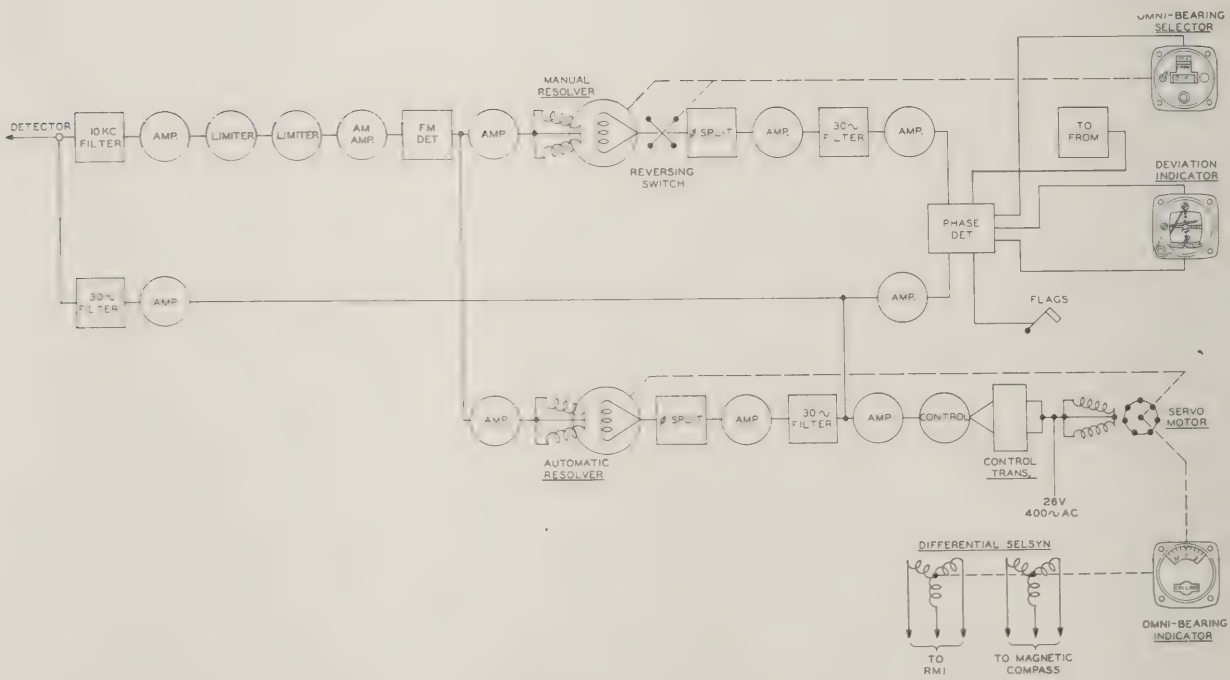


Figure 4-2 Block Diagram of 51R-2 Indicator System

SECTION 4

CIRCUIT DESCRIPTION

4.1. RECEIVER R-F AND AUDIO CIRCUITS.

4.1.1. R-F AND I-F AMPLIFIER CIRCUITS. - The Collins 51R Receiver utilizes a double conversion superheterodyne circuit. One stage of tuned r-f amplification is used. The grid and plate tank circuits of the r-f amplifier, V101, cover the frequency range 108.0 mc to 135.9 mc. The tuned circuits are designed to admit a 2 mc band of frequencies. The output of the r-f amplifier is coupled to the 1st mixer, V102. The excitation voltage for the 1st mixer is supplied by a two stage exciter consisting of a crystal controlled oscillator and a frequency multiplier. The tuning of the grid and plate circuits of the r-f amplifier, the crystal selector switch and the tuning of the crystal oscillator and frequency multiplier circuits is ganged. These ganged circuits are operated by the megacycle Autopositioner. The megacycle Autopositioner has 14 positions. Fourteen crystals are used in the high frequency oscillator circuit. The Autopositioner and the r-f circuit components have been selected so that the 14 positions cover the frequency range 108.0 to 135.9 mc. The positions or channels are 2 mc apart throughout this frequency range.

The crystals in the grid circuit of the high-frequency oscillator tube, V112, have been selected so that injection frequencies in the range 88.5 to 114.5 mc are obtained. These injection frequencies when mixed with the output of the r-f amplifier tube produce intermediate frequencies in the range 19.5 to 21.4 mc. The output of the 1st mixer is fed to the variable frequency i-f amplifier, V103. The tuning of the two i-f transformers, T103 and T104, is ganged with the low frequency injection oscillator crystal selector switch and the tuning of the output of the oscillator. Twenty crystals are available for use in the grid circuit of the low frequency oscillator, V113. The frequencies of these crystals are such that 20 injection frequencies in the range 16.3 to 18.2 mc are available for injection into the 2nd mixer. Eighteen of the twenty crystals operate at one-half output frequency and the other two operate at one-third output frequency (crystals #26 and 30). The i-f oscillator crystal selector switch, the tuning of the oscillator plate tank circuit and the tuning of the variable i-f amplifier stage are operated by the tenth megacycle Autopositioner. Referring to the received frequency, it is thus possible to select any one of 20 frequencies of the 2 mc band of frequencies that is passed by the r-f amplifier.

The Autopositioners are operated by the manual channel selector switch on the control unit and by the motor that is located on the front panel of the receiver. For each position of the megacycle positioner, 20 positions of the tenth megacycle positioner are available. The selecting of the desired channel selector automatically operates the Autopositioners to select the proper crystals for both oscillators and tunes the r-f amplifier and variable i-f amplifier stages to the desired frequency. The output of the i-f oscil-

lator is in the frequency range 16.3 to 18.2 mc. Twenty different frequencies in this range are available for injection into the second mixer. Because the crystal selecting and tuning circuits are ganged, the injection frequency that will result in a 3.2 mc i-f signal is always automatically selected.

The remote control unit, 314U, provides control for the 280 channels by use of 28 megacycle positions and 10 tenth megacycle positions. Because of design considerations, these 280 channels are obtained in a slightly different combination in the receiver itself. In the receiver the megacycle positioner controls 14 two megacycle positions and the tenth megacycle positioner controls 20 one-tenth megacycle positions. Thus the remote decimal system 28 x 10 is converted to a 14 x 20 system in the receiver. This is actually accomplished by use of the relay K103 (on the front panel of the receiver) in conjunction with auxiliary remote control switching shown in figure 2-22 The frequency to which the receiver is tuned may easily be determined by means of the dials (on the positioners) which are visible from the front of the receiver with the cover removed. Slots are provided on the positioner main plates through which these dials are visible. To obtain frequency, take the megacycle positioner (upper left) dial reading (108, 110, etc.) and to it add the tenth megacycle dial reading (0.0, 0.1, etc.). Example: Dial readings of 114 and 1.7 denote a frequency of 115.7 megacycles.

The positioners may be manually operated from the front panel of the receiver provided (1) the remote control unit is not connected and (2) 28 volt d-c power is applied to the receiver. A description of manual operation is found in the section entitled "Adjustment and Operation".

The above is in general a description of how the r-f section of the 51R Receiver works. To aid the reader in understanding the methods employed and results obtained, the following table and examples are included.

Channel Selector Position		Received Frequency	Passed by R-F Circuits	1st Mixer Inj. Freq.	Variable I-F	2nd Mixer Inj. Freq.	Fixed I-F
Mc	.1 Mc						
108 mc	0.0	108.0 mc	108.0 to 110.0	88.5 mc	19.5 mc	16.3 mc	3.2 mc
	0.1	108.1	108.0 to 110.0	88.5	19.6	16.4	3.2
	0.2	108.2	108.0 to 110.0	88.5	19.7	16.5	3.2
	0.3	108.3	108.0 to 110.0	88.5	19.8	16.6	3.2
	0.4	108.4	108.0 to 110.0	88.5	19.9	16.7	3.2
	0.5	108.5	108.0 to 110.0	88.5	20.0	16.8	3.2
	0.6	108.6	108.0 to 110.0	88.5	20.1	16.9	3.2
	0.7	108.7	108.0 to 110.0	88.5	20.2	17.0	3.2
	0.8	108.8	108.0 to 110.0	88.5	20.3	17.1	3.2
	0.9	108.9	108.0 to 110.0	88.5	20.4	17.2	3.2
	1.0	109.0	108.0 to 110.0	88.5	20.5	17.3	3.2
	1.1	109.1	108.0 to 110.0	88.5	20.6	17.4	3.2
	1.2	109.2	108.0 to 110.0	88.5	20.7	17.5	3.2
	1.3	109.3	108.0 to 110.0	88.5	20.8	17.6	3.2
	1.4	109.4	108.0 to 110.0	88.5	20.9	17.7	3.2
	1.5	109.5	108.0 to 110.0	88.5	21.0	17.8	3.2
	1.6	109.6	10880 to 110.0	88.5	21.1	17.9	3.2
	1.7	109.7	108.0 to 110.0	88.5	21.2	18.0	3.2
	1.8	109.8	108.0 to 110.0	88.5	21.3	18.1	3.2
	1.9	109.9	108.0 to 110.0	88.5	21.4	18.2	3.2
110	0.0	110.0	110.0 to 112.0	90.5	19.5	16.3	3.2
	0.1	110.1	110.0 to 112.0	90.5	19.6	16.4	3.2

The preceding table shows how the double conversion system operates to obtain the 3.2 mc signal for application to the grid of the 1st fixed i-f amplifier tube, V105. The table could be completed to give the same information for received frequencies up to 136 mc. As will be noted in the table, the r-f circuits pass a 2 mc band of frequencies for each position of the megacycle Autopositioner. The tenth megacycle Autopositioner selects the desired frequency from the 20 frequencies that are available for each position of the megacycle Autopositioner. The frequency of the injection voltage for the 1st mixer changes with the operation of the megacycle Autopositioner, but is the same for the 20 positions of the tenth megacycle Autopositioner. The frequency of the variable i-f amplifier is varied in the range 19.5 to 21.4 mc for each position of the megacycle Autopositioner. That is, the variable i-f is different for each position of the tenth megacycle Autopositioner. The frequency of the 2nd mixer injection voltage is varied in the frequency range 16.3 to 18.2 mc for each position of the megacycle Autopositioner. As a result the fixed i-f is always 3.2 mc.

The fixed i-f system utilizes three stages of highly selective amplification. These three stages of fixed frequency i-f amplification, added to the selectivity obtained in the preceding tuned r-f and i-f amplifier stages, give a very high degree of image and adjacent channel rejection.

4.1.2. DETECTOR, AVC, AUDIO SQUELCH AND NOISE LIMITER. - A diode detector is used to demodulate the signal of the third fixed IF stage: One section of a dual diode is used as a signal detector and the other section as a voltage doubling detector.

The AVC system used in the 51R-2, by the virtue of a voltage doubling detector, maintains the output of the receiver substantially constant over a wide range of incoming signal levels. Operation of the AVC circuit is as follows.

With a signal applied, the left hand section of V108 will conduct on the positive half of the cycle charging condenser C145. On the negative half of the cycle the right hand section will conduct when the sum of negative peak and the charge on C145 exceeds that of the delay voltage. As the charge on C145 is negative it is added to the negative peak thus obtaining a voltage doubling effect. The rectified AVC developed across R145 is applied through its appropriate filters to indicator circuits and also to the controlled IF and RF stages of the receiver.

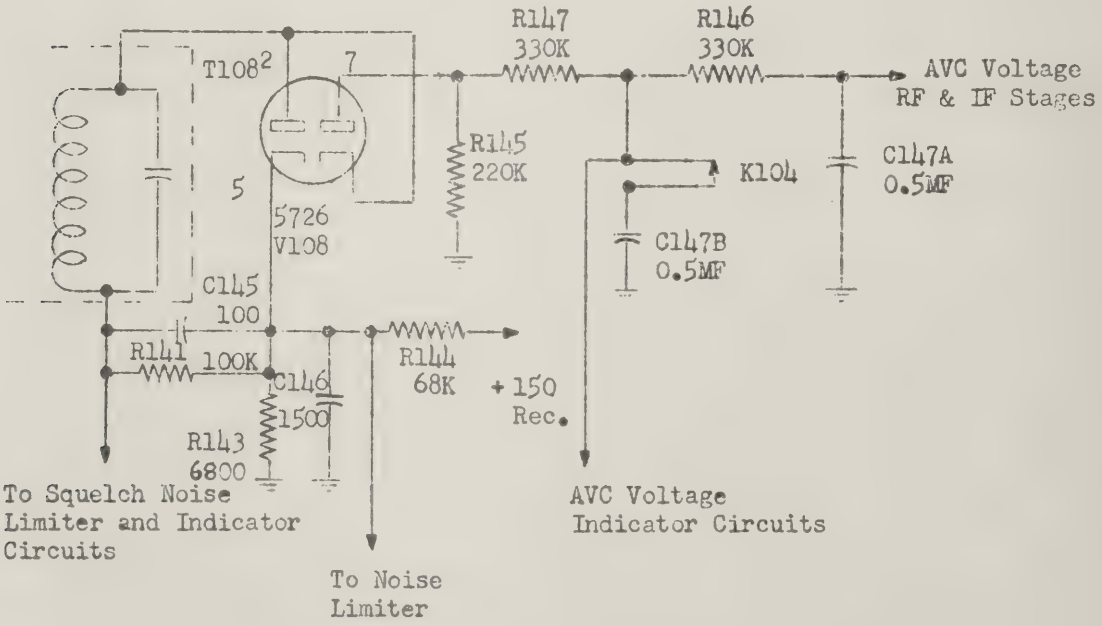


Figure 4-3 Detector and AVC Circuit.

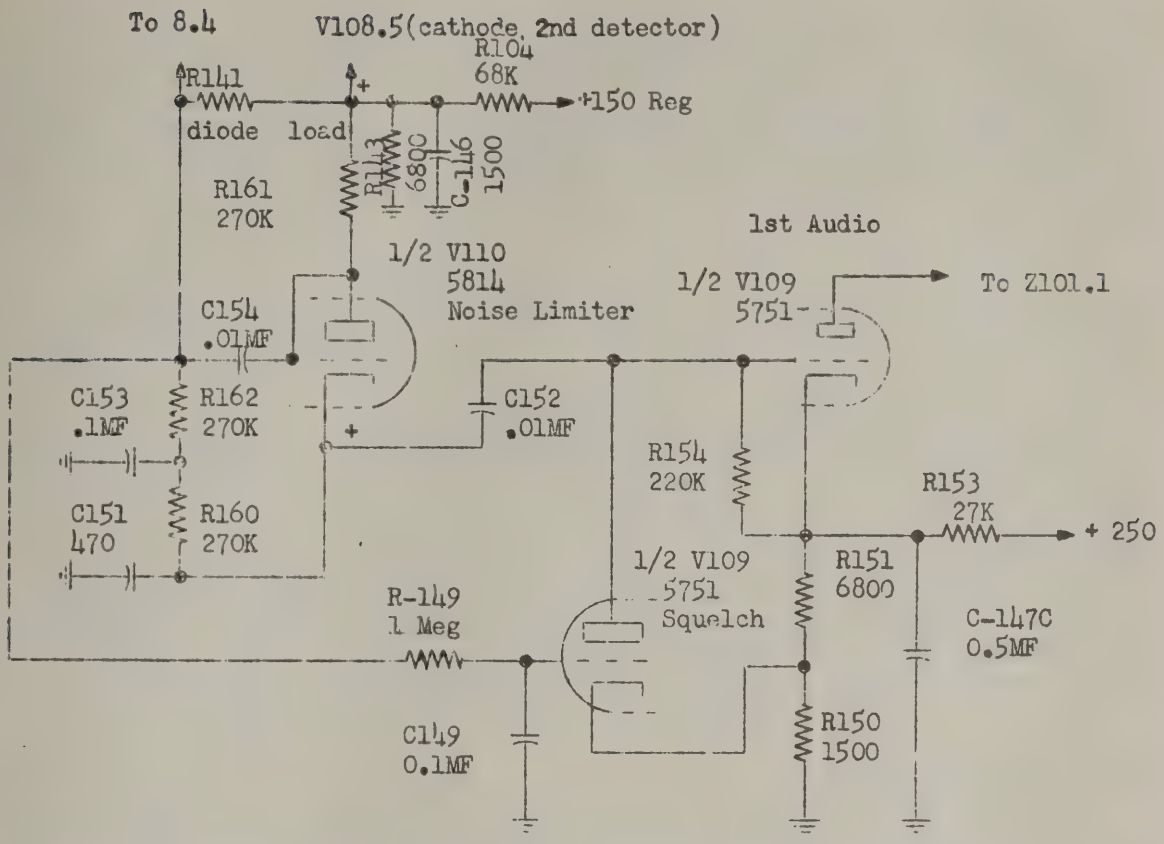


Figure 4-4 Noise Limiter and Squelch Circuit

The noise limiter in the 51R-2 Receiver utilizes the right hand section of V110 in a peak-clipping, series type, limiter circuit. In operation, the pulsing negative voltage (with respect to cathode of 2nd detector) is applied to the cathode of limiter section of V110. This voltage varies with the amplitude of the signal. The plate of limiter section of V110 is coupled through capacitor C154 to the varying negative potential (with respect to cathode of 2nd detector) and the cathode is connected to the same point through the filter section consisting of R162, C153, R160, and C151. As a result of the negative d-c potential (with respect to the cathode of the 2nd detector) applied to the limiter cathode, current flows through the limiter tube. This current varies at an audio rate as a result of the voltage developed in the detector circuit. The voltage developed across resistor R160 is applied to the grid of first audio amplifier stage. A sharp noise pulse, having an amplitude greater than the desired signal, and after rectification, being in the form of a sharp d-c pulse is coupled by capacitor C154 to the

limiter plate V110. This pulse causes the negative voltage (with respect to the cathode of 2nd detector) on the plate of the limiter V110 to become equal to or less than the voltage applied to the cathode of the limiter. Therefore, for the instant, current flow through the limiter section of V109 is interrupted and the noise above a certain percentage of modulation is not allowed to appear in the grid circuit of the first audio amplifier stage. As the noise peaks are usually of short duration and the recovery time of the limiter is practically instantaneous, the interruption of the signal is not noticeable.

The audio squelch system utilizes the left hand section of V109. The operation of the circuit is as follows. Essentially the desired condition is that the 1st audio amplifier stage, right hand section of V110, be biased to cut off when no signal is being received; and this bias to be removed when signals are received. The left hand section of V109 develops this biasing voltage. The grid of V109 is connected to the junction of T108 and diode load resistor R141, and utilizes the voltage developed across the diode load resistor. With no signal received, the d-c voltage at the junction of R141 and T108.4 is greater than the positive voltage across R150 and tube V109 conducts. The current develops a negative voltage across R154 which is applied to the grid of the first audio amplifier, left hand section V109, which is biased to cut-off and the receiver is silent. With a signal being received, the junction of the diode load resistor R141 and T108.4, becomes less positive causing the squelch to be biased to cut-off. With bias voltage being removed from R154, the 1st audio amplifier functions normally and the audio signal appears in the output of the first audio amplifier.

4.2 INDICATING SYSTEM.

The 51R Receiver includes facilities for operation of the omnidirectional range and localizer indicating system. The radial converter indicator, which combines the magnetic and omnidirectional course information, is a separate instrument unit, but is controlled by a servoamplifier which is an integral part of the radio receiver.

In order to insure safe and reliable use of the cross pointer track indicator, two auxiliary indicators are provided. These are (1) the flag alarm indicator on the face of the cross pointer meter, which obscures a portion of the needle when signal falls below a safe value, and (2) a TO-FROM meter which comprises a zero center up-down meter which reads in the "TO" sector when the aircraft is on a course reading toward the station, indicates in a "FROM" sector when the aircraft is on a course reading away from the station, and moves to a center section when either the reference or variable signals fall below a safe level.

The flag alarm indicator is operated from a rectified voltage taken from the phase detector signals. The TO-FROM indicator is operated from a phase detector which is combined with the phase detector operating the course needle on the cross pointer indicator. In order to properly control the TO-FROM indicator, it is necessary to shift the phase of the variable voltage

entering this second phase detector through an angle of 90 degrees. This means that the indicator will show the pilot which side of the station he is on, and will swing from a "TO" correct reading to a "FROM" incorrect reading if the aircraft crosses a course line 90 degrees displaced from the selected course. This has the effect of dividing the area around the station into four general areas.

For operation of the radio magnetic indicator on an automatic basis, a second resolver is energized in a similar manner to the resolver in the radial selector indicator, and this second resolver is automatically brought to a phase balance by a servo motor.

Provision for flying 90/150 cycle modulated localizers is made through the usual rectifier-filter arrangement. The flag alarm indicator of the cross pointer meter is controlled in a conventional way through the use of the common current flowing in the rectifier circuit.

Operation of the cross pointer indicator on phase modulated localizers is provided for through the use of the phase detector which forms a part of the omnidirectional range indicator circuit. When flying phase type localizers, the reference input to the phase detector is switched so as to bypass the resolver in the manual course setting instrument.

4.3 DETAILED DESCRIPTION OF 51R-2 INDICATOR CIRCUITS

4.3.1. INSTRUMENTATION CIRCUITS. - With reference to the schematic, figure 7-3, it will be noted that the receiver output appears across detector load resistor R141 with respect to ground. Tracing first the path of the signal through the reference channel, we note that the VOR signals composed of the 9960 FM and 30 cycle variable appear at T108 terminal 4 and are conducted through the shielded lead to C156. This capacitor presents a high reactance to the 30 cycle component, but allows the 9960 FM to pass through with negligible attenuation. Resistor R163 and resonant filter Z102 form a band pass filter which permits the 9960 including its FM side bands to appear at grid 7 of V115. The Q of this filter is in the order of 5, and is controlled primarily by the shunt resistor R164 which is connected across the filter. The filter itself is hermetically sealed and is comprised of a toroidally wound powdered iron core inductance and a highly stable silvered mica capacitor. The action of the filter on the FM causes a negligible amount of delay and also introduces some degree of amplitude modulation due to its pass band characteristics. As will be seen later, this amplitude modulation is of negligible significance since it is followed by severe limiting.

Reference amplifier V115 is a conventional resistance coupled amplifier stage and it is concerned primarily with the amplification of those frequencies in the neighborhood of 9960. It is resistance coupled to grid 2 of the first limiter stage which performs as a cathode follower limiter in conjunction with the other half of V116 connected as a grounded grid amplifier. It can be shown that the negative going half cycle of signal impressed at grid 2 will be

driven into plate current cutoff by the action of cathode follower section and the succeeding half cycle will be driven into plate current cutoff due to the action of the grounded grid amplifier. Thus, limiting is achieved without grid current and by completely eliminating any circuit currents proportional to that part of the signal which is undesired. The grounded grid section of V116 is coupled to the second limiter V117 which is a duplicate combination of cathode follower and grounded grid amplifier, and performs exactly as the first limiter. The input to the second limiter is essentially a square wave and the output of the second limiter approaches a perfect square wave, except for loading effects of following slope circuit. This square wave output from plate 1 of V117 is applied to the discriminator amplifier V118 through coupling capacitor C159 and an anti-resonant filter section comprised of R173, an inductance housed within T113 and tuning capacitor C160. The inductance employed in this anti-resonant filter is toroidally wound on a powdered iron core and has an internal spoiling resistor to decrease the Q of the anti-resonant circuit unloaded to a nominal 12. The generator impedance driving this filter is such that the circuit Q is in the order of 5. It should be stated that the actual winding resistance of this inductance contributes a negligible amount toward the circuit Q, this being primarily determined by internal shunt resistance and generator impedance. Capacitor C160 is a highly stable silvered mica of such magnitude as to tune the anti-resonant circuit somewhat above 9960. By so doing, the FM spectrum falls on the low frequency side of resonance on a linear portion of the resonant response curve, and thus generates amplitude modulation as a function of deviation ratio and the Q of the anti-resonant circuit. It should be stated here that due to the very effective limiting preceding this circuit that the amplitude modulation appearing at grid 7 on the discriminator amplifier (V118) is for all practical purposes independent of any amplitude modulation due to receiver non-linearity, propeller modulation, or amplitude modulation originating at the transmitter. The amplitude modulated envelope is amplified by the discriminator amplifier. It passes through linear transformer T113 where a bridge rectifier E101 demodulates the AM which results in a 30 cycle signal directly proportional to the deviation ratio on the subcarrier.

Capacitor C162 and resistor R176 comprise the rectifier filter and load respectively. Inasmuch as the center of the rectifier output load resistance, R177, R178 is grounded, it is possible to obtain two 30 cycle signals in phase opposition. Capacitors C163 and C164 provide d-c isolation of the following grid circuits from the rectifier output. Grid 2 of the OBS resolver amplifier V115 couples the reference 30 cycle signal to the resolver rotor by virtue of cathode follower action. R179 serves as a swamping resistor to provide constant current resolver input and thus minimize variations in copper winding resistance of the resolver rotor. Tracing the schematic diagram, it will be noted that cathode 3 of V115 is connected to the omni-bearing selector rotor through switch contacts S103.13 and S103.3 and S103.19, the latter two connected in parallel. This connection exists for omni-range operation. It

should be noted that the schematic is drawn for the circuits obtaining when the receiver is set up at 108.0 mc. It should further be noted that relay K105 which serves to distinguish between phase localizer and tone localizer operation is in the released position, thus satisfying the requirements for phase localizer. Such being the case, S103.13 is shown connected to S103.11 which in turn effects a bypass on the omni-bearing selector, and provides excitation for reference amplifier V119 by the introduction of reference signal across R183 in the cathode circuit of this amplifier. Returning to omni-range operation, it will be seen that the stator outputs of the omni-bearing selector resolver are coupled to Z104 through tracking control R181 to terminal 1 and direct to terminal 2. This provides an RC circuit having a resistance equal in magnitude to the reactance of the capacitor. R181 provides the means for establishing this equality. Thus, the electrical output at the junction of the first 256,000 ohm resistor and .02 mf capacitor will follow in phase angle the mechanical rotation of the rotor controlled by the knob on the omni-bearing selector in the cockpit. The second RC section performs as a low pass filter section to eliminate higher order frequencies coming from and through the resolver and accentuated by the constant current excitation of the resolver rotor. The output of Z104 is connected to the grid 2 of V119 through a length of shielded cable where it is amplified by the cascade amplifier V119. The output of the first section of V119 is coupled through coupling condenser C165 to grid 7 of the second section where it is further amplified and in turn coupled through C166 and R189 to the anti-resonant circuit comprised of T114, C167, and C193. Resistor R188 provides a feedback loop in conjunction with R182-R183 which serves to stabilize the gain and phase shift through the reference amplifier. R182 and R186 are cathode bias resistors. R184, R187 are plate coupling resistors. R185 serves as grid return for grid 7 of V119. The plate supply to the reference amplifier is decoupled through R190 and C190 to prevent B+ disturbances from affecting the performance of this amplifier. Resistor R189 in conjunction with T114 and C167 serves as a means of establishing a rate of phase angle change versus modulation frequency change, and is the prime contributor in the OBS reference channel toward establishing overall frequency compensation. Capacitor C167 tunes the secondary of T114 to parallel resonance at or very near 30 cycles. The secondary of T114 is connected as an autotransformer to provide push pull excitation for the grids of reference amplifier V120. The purpose of capacitor C193 is to provide a very small increment of tuning to enable T114 to be adjusted to exact 30 cycle resonance as determined by the condition of zero phase shift across R189. Reference amplifier V120 serves as a straight amplifier to provide the power necessary to drive the reference portion of the deviation indicator circuit. Transformer T115 couples the output of V120 to the metering circuit. The primary of T115 is tuned precisely to 30 cycles resonance in order that the variations in plate resistance due to tube interchange can be absorbed without variation in phase angle.

Leaving the reference channel at this point, we now return to the detector V108 where it is seen that a 30 cycle variable signal is obtained at the junction of R141 and T108.4 and coupled through C170 to a network of resistors comprised of R245, R192, and R193. For VOR operation resistors

R192 and R245 serve primarily as grid returns for grid 2 of V121. Resistor R193 serves to establish a phase shift versus modulation frequency change characteristic of the following filter circuit made up of Z103, C172, R194 and R246. Resistor R246 serves to swamp the variation of winding resistance in Z103 and thus reduce phase shift as a function of winding resistance variation to a negligible quantity. Filter Z103 consists of a stable inductance connected between terminals 5 and 1, in addition to a highly stable silvered mica capacitor connected between 5 and 2. Terminals 1 and 2 are connected together, thus providing a parallel resonant circuit tuned to 60 cycles. Z103 and C172 form a resonant circuit tuned somewhat below 30 cycles (approximately 25). By so doing, a steep attenuation characteristic between 30 cps and frequencies slightly higher is established, thus tending to minimize some of the difficulties encountered in aircraft having propellers creating unwanted modulation in the range of 35 to 40 cycles. Resistor R194 serves as a control over the absolute phase shift through the filter, and thus permits continuous variation in phase angle over a range of approximately 5 degrees. Resistor R243 and capacitor C171C form a decoupling circuit for the audio AVC applied to grid 2 of the variable amplifier V121. This provides a very small amount of forward acting AVC sufficient to establish stable deflection sensitivities over a wide range of r-f signal input. Variable phase amplifier V121 is a push pull stage obtaining excitation for grid 7 from the voltage divider comprised of R199 and R200. The plate supply to this stage is decoupled from B+ through resistor R198 and capacitor C173A, thus providing a substantial degree of isolation from B+ disturbances. Resistors R196 and R197 serve as plate coupling resistors for V121, and R195 is employed as a common cathode bias resistor. The output from V121 is coupled to variable phase amplifier V122 through coupling capacitors C174 and C175. The values of the coupling capacitors are such that there is a tendency to discourage amplification of the low frequency products of propeller modulation in the region of 10 to 20 cycles, thus improving to some degree indicator stability under conditions of severe propeller modulation. Resistor R201 and resistors R199 plus R200 serve as grid returns for variable amplifier V122. V122 serves as a meter circuit amplifier and raises the power level to a suitable magnitude for excitation of the meter circuit. This power is transferred through T116 to the meter circuit. The primary of T116 in VOR and phase localizer operation is resonated at 30 cycles by means of C176 and C177. The purpose of C177 is to bring the primary to exact resonance in order that variations in resistance resulting from tube interchange will not produce phase shift. When the receiver is used on the tone localizer facility, contacts L10 and L11 are broken, thus allowing V122 and V116 to behave as a linear amplifier over the region of 90-150 cycles.

Considering now the deviation indicator metering circuit, it will be seen that part of the reference channel output is added to a similar portion of the variable channel output by virtue of transformer secondary connections, and that the vector sum of these two voltages is applied to one section of double bridge rectifier E102. It will be noted that the other half of the double bridge rectifier is driven in an identical fashion with the exception that one winding polarity has been reversed in the interconnection process. Thus we have established the condition where the vector addition of one combination of

windings with respect to the vector addition of the other combination produces a differential in a-c voltage which in turn is rectified and appears across load resistors, R233, R234, and R235, as a differential d-c voltage which in turn will result in deflection of the deviation indicator depending on the original polarity of the voltage differential. The purpose of resistor R227 and R228 is to stabilize the rectified current as a function of variation in individual rectifiers of the double bridge assembly E102. Resistor R233 plus a portion of R234 serves as the load resistor for section 2-3 of the double bridge, and resistor R235 plus a portion of R234 serves as a load resistor for section 6-9 of the double bridge. R234 provides a differential adjustment of one bridge output with respect to the other when measured across the double bridge load, and thus serves as a metering circuit balance adjustment to eliminate the original unbalance currents which may result from slight differences in the two bridges as well as tolerance variation in R227-R228-R233-R235. Resistor R231 through which the combined output of each bridge passes, creates a small voltage drop proportional to the percentage modulation of the signals involved and which is applied to the flag movements of two deviation indicators. In the event only one deviation indicator is employed, the equivalent resistance of the second, 1000 ohms, should be substituted as part of the aircraft installation. The value of R231 has been chosen so that in the absence of the reference or the variable signal the flag alarm will show, thus indicating to the pilot that either the airborne or the ground VOR facility is no longer reliable and should not be used. Resistor R232 which during VOR and phase localizer operation is shorted out, provides additional drop when the receiver is used on tone localizer facilities to accentuate the flag alarms in a fashion similar to that just described. The value of R232 has been chosen so that in the absence of either the 90 or the 150 cycle modulation, the flag alarm will show. Variable resistor R238 serves as deviation indicator sensitivity control for phase localizer operation, and is short-circuited when the receiver is using a VOR facility. Variable resistor R239 serves as sensitivity control for VOR providing an adjustment in the order of from a maximum sensitivity of 17 degrees to a minimum sensitivity of approximately 30 degrees course width. The relative magnitudes of R238 and R239 are such that small variations in R239 resulting from adjustment of VOR course width will have a negligible effect on phase localizer course width. Tone localizer sensitivity is controlled by adjustment of signal level utilizing variable resistor R245.

An auxiliary circuit which provides To-From indications on VOR reception is comprised of the center-tapped windings 8, 9, and 10, of transformers T115 and T116 plus the phase splitting components C188 and R226, the rectifiers E103 and E104, and the load resistors R224 and R225. This circuit functions to indicate to the pilot on the small To-From indicator housed within the omni-bearing selector as to whether the station being received is ahead of or behind the location of the aircraft at any given time. To provide this information a simple phase detector consisting of the components previously enumerated is adjusted in such a fashion that a condition of balance exists 90 degrees displaced from the condition of balance on the deviation indicator. Thus, when the aircraft is on-course flying toward the station, a d-c output of one polarity will exist across the outer terminals of R224 and R225, and

when the aircraft passes over the station the unbalanced voltage reverses, thus causing the To-From indicator to deflect in the opposite direction. Inasmuch as the stability requirements in this circuit are far less stringent than in the deviation indicator circuit, half wave rectification is employed. One side of the output of this circuit is permanently grounded. When the receiver is tuned to either phase localizer or tone localizer facilities, the other side is also grounded, thus rendering it impossible for the To-From indicator to deflect.

Reference is next made to the circuitry involved in providing automatic indication by means of the servo driven omni-bearing indicator. OBI resolver amplifier V118 provides cathode follower excitation direct through swamping resistor R180 to the rotor of the resolver housed within the OBI. There is no switching involved in this circuit as was employed in the OBS resolver amplifier. One stator of the OBI resolver returns to the receiver through P101 to tracking control R203 and thence to terminal 5 of Z104. The other stator returns through P101 direct to terminal 6 of Z104. The variable resistor R203 plus the 256,000 ohm resistor and associated .02 mf capacitor form a phase splitting network which permits the voltage appearing at the junction of the capacitor and resistor to follow in electrical phase angle the mechanical rotation of the OBI resolver rotor degree for degree in the same fashion as described previously relative to the OBS. The 256,000 ohm resistor and .02 mf capacitor following these phase splitting components provide low pass filter mg for the same purpose as described previously in the OBS circuit. The shielded lead brings the filtered resolver output from Z104 to grid 2 of the OBI amplifier V123. It will be noted that the OBI amplifier is in most respects identical to reference amplifier V119. Notable exceptions are that in the case of V123 there is no requirement for injection of phase localizer signal, consequently R204 cathode bias resistor is connected directly to ground. Further, a greater amount of inverse feedback is applied in the case of the OBI amplifier, since accuracy here is to a greater extent than in the manual circuits dependent upon very good wave form. Resistors R206 and R209 serve as plate coupling resistors. R207 serves as a grid return for grid 7, R208 provides cathode bias for the second section of V123, and C178 and C179 serve as coupling capacitors for both stages. The plate power to this amplifier is decoupled from B+ through resistor R210 and capacitor C173B. Resistor R211 serves as a frequency compensation determining element in a manner similar to that described for R189. Likewise, transformer T117 is tuned accurately to 30 cycles by means of C180 and C194, and provides filtering action similar to that in T114. Transformer T117 is used as an autotransformer with the center tap grounded to a-c through capacitor C171B. OBI phase detector V124 provides the necessary mixing of reference and variable phase signals to enable a differential amplitude to be obtained which is a function of the phase angle change between reference and variable. The grids of V124 are excited with reference signal only, inasmuch as resistor R224 and capacitor C171B provide about 34 db of attenuation to the variable channel signal. The mixing of reference and variable signals is done in the cathode circuit by means of common currents flowing through resistors R213 and R214. The variable current originates from OBI injection tube V126 cathode number 8, and is tied

directly to the cathodes of V124. Signal for the injection stage is obtained from the output of variable amplifier V121. Resistors R213 and R214 serve as a voltage divider to raise the grids of V124 a few volts d-c above ground, thus partially canceling the increased self-bias formed by currents of both V124 and the lower section of V125. In a condition of balance (OBI stationary), the plate currents flowing in V124 stage are approximately in quadrature. Resistors R215 and R216 provide plate coupling to V124 and resistors R217 and R218 serve as grid returns for the OBI reactor control V125. Coupling capacitors C182 and C183 provide relatively high reactance to the modulation frequencies, and provide higher reactance to those frequencies below the desired modulation resulting from the products of propeller modulation. Consequently, there is considerable rejection to these unwanted low frequencies at the grids of V125. Grid signal amplitudes are in turn a control of the plate currents flowing through each half of V125 and through the saturable reactor T118. Potentiometer R219 provides a differential plate current adjustment of one section of V125 with respect to the other, and thus is a means of varying the balance point or indication of the OBI. Resistor R220 provides self-bias for V125 in conjunction with R221 which is selected to permit operation of the control stage at a plate current of about 1 ma. per section. Capacitor C184 provides cathode bypass action at the signal frequency. Capacitors C185 and C186 provide a shunt path around the reactors for the rectified peak signals impressed at the grids of V125. The upper half of V126 provides a means of eliminating the surges of current drawn from the B+ by the reactor control stage. It will be noted that the combined plate power for V125 and V126 must flow through R240. By coupling the surges which appear at V126 due to power requirements of V125 back into the grid circuit, similar surges opposite in phase and approximately equal in magnitude flow through V126. Thus the overall effect of the reactor control stage on the B+ of the entire receiver is minimized, resulting in improved accuracy and elimination of B+ modulation of the receiver portion of the radio. Capacitor C189 and resistor R241 provide the necessary feedback for this function. Resistor R242 provides self-bias for the OBI regulator. Capacitor C181 provides a shunt path to ground at high frequencies, and is employed to eliminate the possibility of oscillation in V126 due to wiring inductance. Capacitor C187 serves as a motor control capacitor and enables quadrature excitation of one phase of the two phase OBI control motor with respect to the other. Resistors R222 and R223 provide direct current damping in the OBI motor winding, thus eliminating any tendencies toward hunting. It will be noted that a means is provided for opening the circuit between R223 and pin 5 of T118, thus disabling the omni-bearing indicator. Switching is provided on the course frequency selector switch wafers to enable the OBI in the VOR band. Resistors R248 and R249 serve as filament dropping resistors for the entire radio. Resistor R237 which parallels the V116 filaments, serves to equalize current drain through the filament string. Capacitor C192 provides an r-f bypass to ground.

When the receiver is set up for 90-150 localizer operation by means of the frequency selector, K105 relay contacts shown on the schematic diagram move to contacts now shown as unused. Further, on tone localizer operation,

the reference channel is not used. Filter Z102 prevents 90 or 150 cycle signals from obtaining access to this channel. The localizer signal as obtained at the junction of R141 and R142, passes through C170 and appears across the combination of R192, R245 and to a negligible extent C171C. As stated previously, R245 establishes localizer sensitivity and the signal is traced from the arm of this control to K105-T6 where it is then connected to grid 2 of V121. This amplifier functions as previously with the exception that signals are now a mixture of 90 and 150 cycles instead of 30. Variable amplifier V122 is excited as before, except that its plate circuit is no longer tuned to 30 cycles. Switch K105-L11 is now connected to L12 and the output of V122 is impressed across the paralleled inputs of 90 and 150 cycle localizer filters Z105 and Z106 respectively. It will be noted that the high potential side of T116 is connected to the arm of localizer centering control R236, and that the low potential side or center tap of T116 is connected to terminal 3 of both filters. A small neon discharge lamp is connected across the inputs of the localizer filters which will ionize and thus tend to reduce the effects of surges, if present. The ionizing potential of these lamps is in the order of 2 to 3 times the operating voltage of the filter inputs. The output of the 90 cycle filter is connected to one half of a double bridge rectifier E102 through K105-T11 and T12. The other side of the 90 cycle filter is connected directly to terminal 6 of the same bridge. In a similar fashion of the output of the 150 cycle is connected to the lower bridge of V102. Also contacts K105, L-1 and L-2 are no longer connected, thus providing necessary IR drop for flag performance. Contacts L5 and L6 of K105 are connected, thus providing a direct path to the deviation indicator terminals.

4.4 AUTOPOSITIONER SYSTEM

To provide automatic remote selection of receiver frequency, the type 51R-2 receiver is equipped with a Collins Autopositioner rotary positioning system. This system consists of two Autopositioner units driven by a common motor and a 9 - wire simplified control system. The megacycle-determining Autopositioner unit is controlled by the megacycle-selecting switch of the frequency-selector unit and operates the crystal selector switch associated with the HF injection oscillator-multiplier, as well as the slug rack which tunes the receiver front end circuits. The tenth-megacycle Autopositioner unit is controlled by the tenth-megacycle selecting switch of the frequency-selector unit, and operates the crystal switch associated with the LF injection oscillator-multiplier, as well as the slug rack associated with the tunable IF amplifier.

The Autopositioners, motor, and drive gears are all mounted on the front panel of the receiver (see figure 7-6), normally covered by a dust cover fastened to the panel.

The Autopositioner is a motor-driven mechanism which will position a shaft to any one of a number of fixed positions by remote control. The basic elements of the Autopositioner, as shown in figure 4-5, consist of a motor and its gear reduction, a slip clutch, a rotary shaft to which is fastened

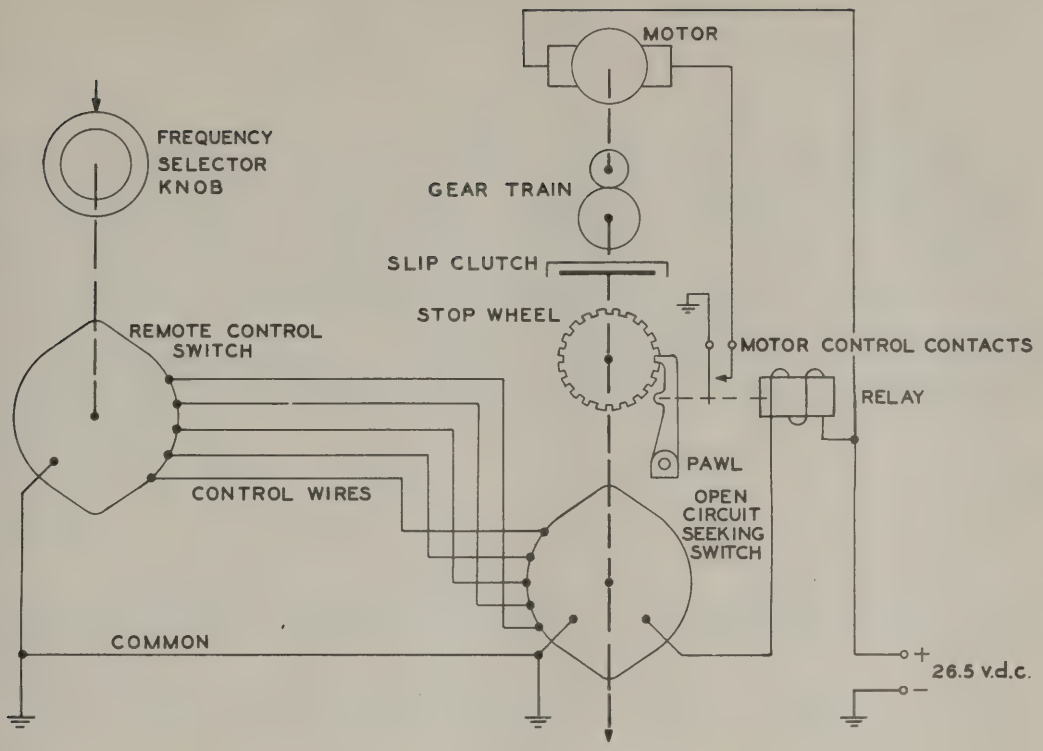


Figure 4-5 Functional Diagram of Autopositioner System

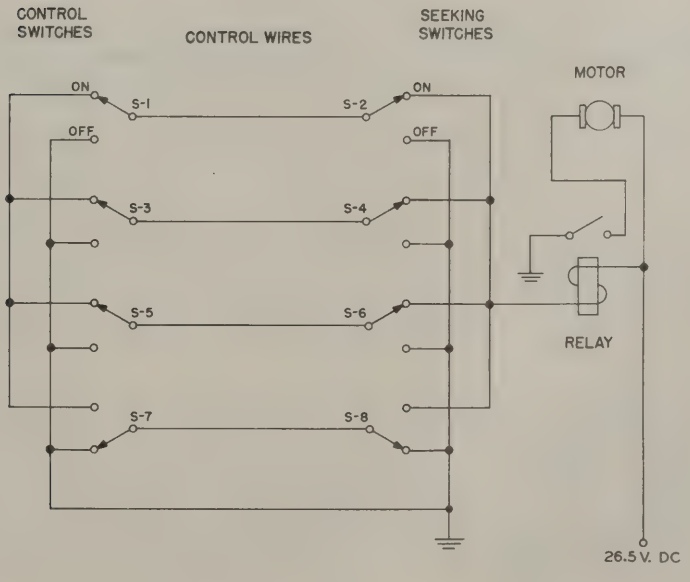


Figure 4-6 Basic Diagram of Simplified Control System

a notched stop-wheel, a pawl which engages the notches of the stop-wheel, and a relay which actuates the pawl and also operates a set of electrical contacts to start and stop the motor. Associated with each Autopositioner unit is an electrical control system consisting of a remotely located control switch actuated by the frequency-selector knob and a similar "seeking" switch driven by the Autopositioner shaft. This control system is of the "open-circuit seeking" type, designed so that whenever the control switch and seeking switch are not set to the same electrical position, the Autopositioner unit is energized and operates to drive its shaft (and the driven elements to which it is coupled) to the proper position to restore the symmetry of the control system.

Referring to figure 4-5, the cycle of operation of the Autopositioner is as follows:

(a) The system is at rest with the control and seeking switches in corresponding positions (open circuit), relay in de-energized position, pawl engaging a stop-wheel notch, and motor not energized.

(b) The operator changes the setting of the remote control selector switch.

(c) The control system energizes the relay, lifting the pawl out of the stop-wheel notch and closing the motor control contacts.

(d) The motor starts, driving the Autopositioner shaft and the rotor of the seeking switch.

(e) The seeking switch reaches the point corresponding to the new position of the remote switch, opening the relay circuit, permitting the pawl to drop into the corresponding stop-wheel notch to stop the shaft rotation.

(f) The motor control contacts open, and the motor coasts to a stop, dissipating its kinetic energy in the slip clutch.

The seeking switch of the control circuit is adjusted to open the relay circuit shortly before the stop-wheel reaches the point where the pawl engages the proper notch. The relay contacts controlling the motor are mechanically operated by the pawl arm so that they do not open until the pawl does drop into the notch.

Note that the slip clutch between the motor and Autopositioner not only absorbs the energy of the motor as it coasts to a stop, but also permits the same motor to drive more than one Autopositioner, either simultaneously or independently. When this is done, as it is on the 51R-2, the motor control contacts of the Autopositioner relays are connected in parallel to keep the motor operating as long as any of the Autopositioners are energized.

To provide a positive control system for the Autopositioners with a minimum number of control wires, a special "simplified" control system has been developed, using the control wires in various different combinations. In the type 51R-2 receiver, four wires are employed to control the megacycle Autopositioner unit (14 active positions), and five control wires are used to control the tenth-megacycle Autopositioner (20 active positions). A common return (ground) wire is used for both sections of the circuit.

This system is most readily explained by considering a system composed of single-pole double-throw switches as shown in figure 4-6. Note that when the switches are set symmetrically (S-1 in the same position as S-2, etc., as shown), there is no current path from the relay coil to ground, and the relay and motor remained de-energized. If, however, any one of the control switches is set to a position opposite to that of the corresponding seeking switch, a path to ground will be closed, energizing the relay and motor until the seeking switches are re-positioned (by means discussed below) to positions symmetrical to the remote switches, which will again open the relay circuit.

The total number of different combinations of switch positions in such a system is 2^n, where "n" is the number of control wires used. In the four-wire system shown, $2^4 = 16$ different combinations exist. However, one particular combination is not usable in this application. As can be seen from figure 4-6, if all the seeking switches are set to the "OFF" position, there can be no path from the relay coil to ground, no matter how the remote switches are set, and the system is "dead". Hence the maximum number of usable combinations in such a system is 2^n-1. Thus, a 3-wire system can control 7 positions, 4 wires 15 positions, 5 wires 31 positions, etc.

To make the system of figure 4-6 physically usable for controlling rotary shaft positions, leaf-type single-pole double-throw switches could be used, actuated by means of a group of four cams mounted on the rotary shaft, the cams being cut to actuate the switches to a different combination for each shaft position, identical cams and switches being used on the remote shaft and on the motor-driven shaft.

To eliminate the bulk and complexity of such an arrangement, special rotary wafer-type switches have been devised to perform the same function. The switches used in the 51R-2 are shown in the schematic diagram, figure 2-23. Each switch consists of two rotor blades, mounted on opposite sides of the switch rotor, and insulated from each other. These take the place of the "ON" and "OFF" parallel-bus connections of figure 4-6.

Looking at switch S401A in figure 2-23, for example, the control wires A, B, C and D terminate in contacts 3, 4, 5 and 6. These contacts consist of clips on both sides of the switch, and since the two blades are cut to complementary patterns, each control wire is connected to either the front or rear blade of the switch as the switch rotor is turned. The clips and blades cooperate, therefore, to produce a system of two-position contactors analogous to the system shown in figure 4-6.

The seeking switch, S101 in figure 2-23, is similar to the remote switch S401A in that it presents the same sequence of front and rear blade connection to the clips 15, 16, 17 and 18, which are the other terminal points of control wires A - D. When the two switches are on corresponding positions, both ends of each control wire contact the same side (front or rear) of the respective switches, and the relay circuit is open, since the front blades of both switches are grounded by means of the long clips shown, and the rear blade of S101 is connected to the Autopositioner relay by the long clip at position 5.

Note that S101 is a 20-point switch whereas S401A is a 14-point switch. The six extra points on S101 provide a return section for the slug rack cams. The megacycle Autopositioner is prevented from stopping on any of these unused positions by the section (shown at the top of the switch) in which both the front and rear blades project. When this section of the rotor blades makes contact with any of the control wire clips, a direct path from the relay to ground is closed, keeping the relay energized.

Since the megacycle tuning of the 51R-2 receiver is done in steps of 2MC, switch S401A is constructed to maintain the same electrical connections on control wires A - D for two successive positions of the megacycle-frequency selector knob: 108 and 109 MC, 110 and 112, etc., as shown by the chart in figure 2-23. Interpolation of the one-megacycle steps from 108 to 109 MC, and so forth, is accomplished by means of switch S401B, control wire J, auxiliary relay K103, and switch S104. On the odd-numbered megacycle, positions of the selector knob, switch S401B energizes relay K103 by grounding wire J. This actuates the contacts of K103 to ground the wire going to clip 5 of switch S104. On the even-numbered positions, relay K103 is de-energized, and grounds clip 15 of S104, as shown in figure 2-23.

The tenth-megacycle remote switch S401D and the corresponding seeking switch S105 are physically and electrically similar. Each is a 20-point switch providing 10 different circuit combinations of control wires E, F, G and H, the sequence of 10 combinations being repeated twice for one complete revolution of the switch. The remote switch S401D is limited to 10 positions by stops, but the seeking switch S105 may stop either of two positions, 180 degrees apart, and find the proper combination to open the main circuit. Which of these two positions satisfies the Autopositioner system is determined by the auxiliary relay K103 and switch S104, which serve to keep the Autopositioner relay circuit energized for the unwanted half of the revolution.

With the megacycle control knob set on an even frequency, as shown, clip 15 on switch S104 is grounded, and the tenth-megacycle Autopositioner may be positioned at from 0.0 to 0.9 MC, corresponding to the position of the tenth-megacycle control knob. Advancing the megacycle control knob to the successive odd-numbered frequency does not change the circuit of wires A - D, and therefore does not operate the megacycle Autopositioner. Instead, it grounds wire J, energizing relay K103, grounding clip 5 of switch S104. This energizes the tenth-megacycle Autopositioner, causing it to advance 180 degrees to the

alternate position of switch S105, in the range of 1.0 - 1.9 MC corresponding to the position one megacycle above the figure shown on the tenth-megacycle control knob.

Thus the tenth-megacycle Autopositioner tunes the receiver in 20 steps of 0.1-MC each to interpolate between the 2-MC steps of the megacycle Autopositioner, whereas the remote control knobs and dials present the frequency data in a decade system of 1-MC and 0.1-MC steps.

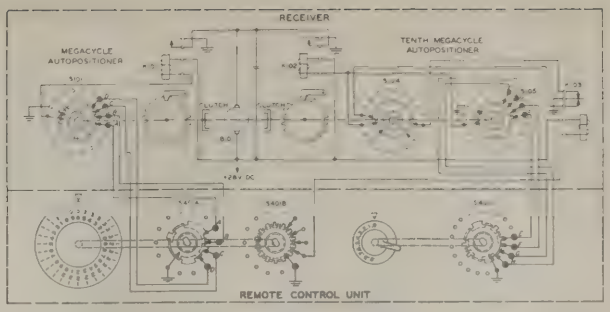
A detailed sequence of operation of the megacycle and tenth-megacycle Autopositioners and control circuits is shown in figures 4-7 and 4-8.

STEP #1 -

a. It is desired to select a receiving frequency of 110.1 mc.

b. Autopositioner system is at rest with receiver tuned to 108.0 mc.

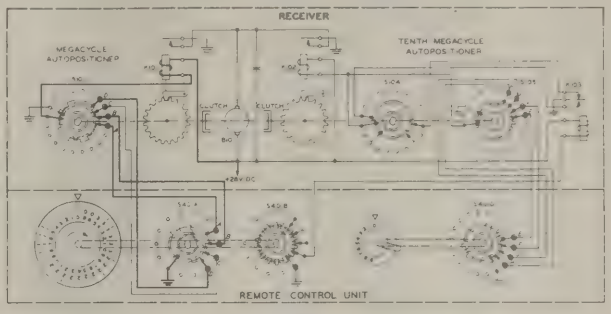
c. Voltage is available to control system. A ground must be supplied before system will operate.



STEP #2 -

a. Megacycle selector on remote control unit is being operated to 110.0 mc position.

b. Coil of relay K101 is energized by connecting ground through switches S101 and S401A.

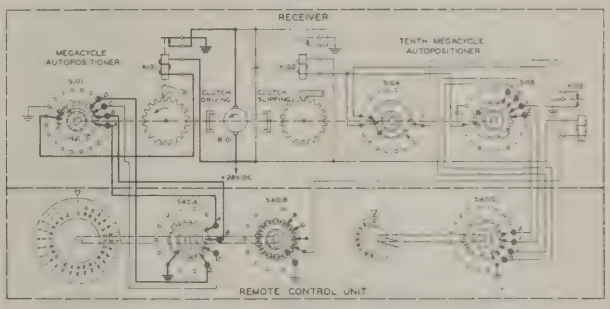


STEP #3 -

a. Relay K101, energized in Step #2, operates, closing motor energizing circuit and lifting pawl out of toothed wheel of megacycle Autopositioner.

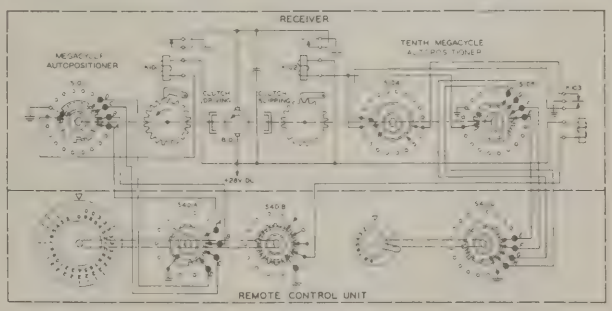
b. Motor B101 rotates, driving toothed wheel and switch S101 through clutch.

c. Clutch of tenth megacycle Autopositioner slips.



STEP #4 -

a. Megacycle Autopositioner rotates until S101 reaches position that breaks continuity of circuit from relay K101 to ground.



STEP #5 -

a. Relay K101 releases, breaking motor energizing circuit and dropping pawl into slot in toothed wheel.

b. System comes to rest at 110.0 mc.

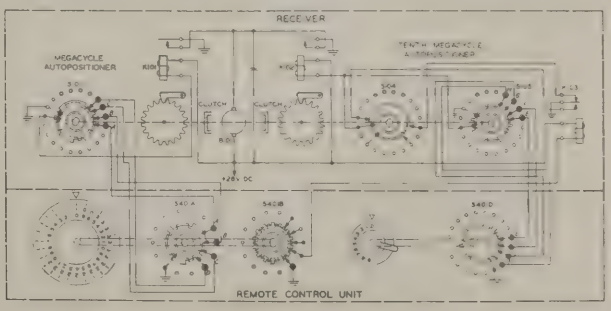
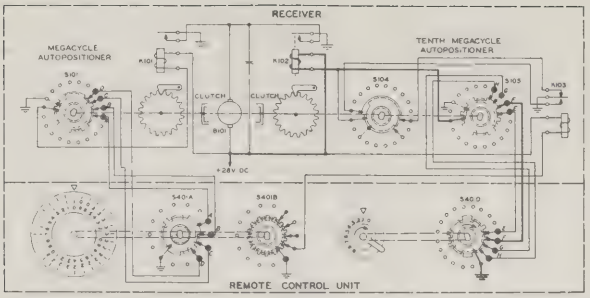


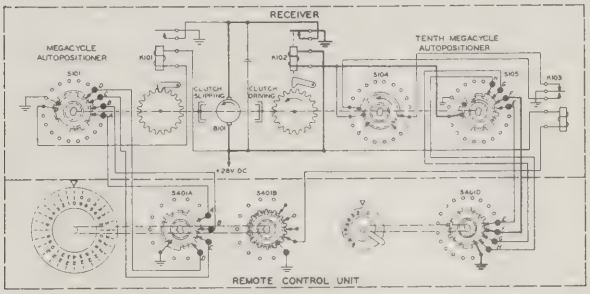
Figure 4-7 Autopositioner Sequence of Operation



STEP #6 -

a. Tenth megacycle selector on remote control unit is being operated to .1 mc position.

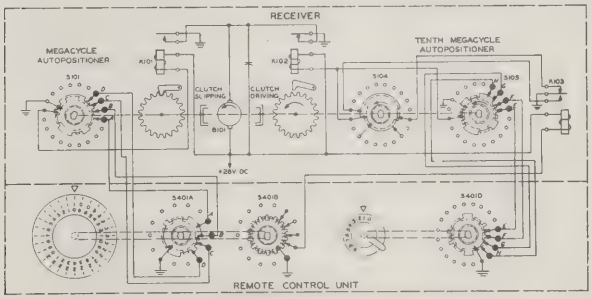
b. Coil of relay K102 is energized through switches S105 and S401D.



STEP #7 -

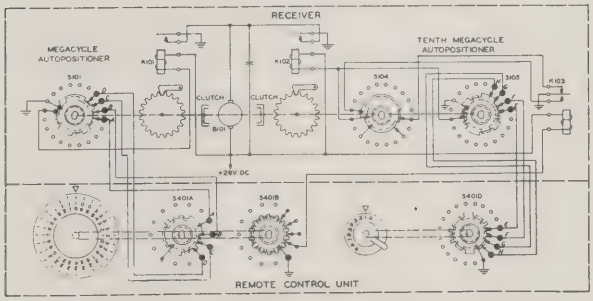
a. Relay K102 operates, energizing motor B101 and lifting pawl of tenth megacycle Autopositioner out of toothed wheel.

b. Motor rotates driving toothed wheel and switches S104 and S105 through clutch. Clutch of Megacycle Autopositioner slips.



STEP #8 -

a. Motor drives tenth megacycle Autopositioner until switch S105 reaches position that breaks energizing circuit of relay K102.



STEP #9 -

a. Relay K102 releases, opening motor energizing circuit and dropping pawl into toothed wheel.

b. System comes to rest at 110.1 mc.

Figure 4-8 Autopositioner Sequence of Operation

SECTION 5

MAINTENANCE

5.1. RECEIVER MAINTENANCE

5.1.1. R-F Section

(a) Circuit Alignment

(1) Fixed I-F Amplifier Alignment

a. Equipment required

1. Signal generator of known accuracy on 3.2 mc, whose accuracy is comparable with accuracy of 51R crystals.

2. Vacuum tube voltmeter.

3. A 4700 ohm resistor and a 10K mmf capacitor in series (for swamping or loading the i-f transformer windings).

b. Alignment Procedure

NOTES: The fixed i-f amplifier (3.2 mc) transformers are slug tuned; transformer primary tuning at top of transformer, secondary tuning at the bottom. Best results are obtained by "swamping" or loading transformer secondary when tuning primary and loading primary when tuning secondary. Combination of 4700 ohm resistor and 10,000 mmf capacitor in series used as load. Observe the stage-by-stage gain as the stages are progressively aligned. Check sensitivity against table of typical sensitivity measurements included in this section.

1. Connect 4700 ohm resistor in series with a 10,000 mmf capacitor between plate of V107 (pin #5) and chassis.

2. Connect vacuum tube voltmeter across diode load resistor.

3. Couple output of signal generator (3.2 mc) to grid of V107 (pin #1).

4. Tune secondary of transformer T108 for maximum diode load voltage.

5. Remove resistor and capacitor from primary of T108 and connect across secondary of same transformer, between pin #3 and #4 of V108 and chassis.

6. Tune primary of T108 for maximum diode load voltage.

7. Repeat steps 1 through 6 above for 1st and 2nd i-f stages, V105 and V106, with vacuum tube voltmeter connected to the AVC line. Tune primaries and secondaries of T107, T106 and T105, in that order, for maximum AVC voltage.

8. When alignment has been completed, check to determine if response is uniform on both sides of 3.2 mc by varying the output frequency of the signal generator on either side of 3.2 mc and observing the variation in AVC voltage.

(2) Variable I-F Amplifier Alignment

a. Equipment required

1. Signal generator covering frequency range 19.5 to 21.4 mc.

2. Vacuum tube voltmeter.

NOTES: Transformers T103, T104 and T110 are slug tuned with powdered iron slugs suspended from table that can be raised and lowered. The alignment consists of positioning the slugs with respect to the position of the table.

b. Alignment procedure

1. Operate the fine frequency Autopositioner to 0.9 mc.

2. Tune the signal generator to 20.5 mc.

3. Couple the output of the signal generator to the grid of V104 (pin #1) and couple the voltmeter to the AVC line.

4. Tune the signal generator until the voltmeter indicates maximum AVC voltage.

5. Tune both slugs in T110 for maximum AVC voltage and couple the output of the signal generator to the grid of V103 and tune T104 for maximum AVC voltage.

6. Couple output of signal generator to grid of V102 (pin #1) and tune slugs in T103 and T104 for maximum AVC voltage.

7. Check overall sensitivity of i-f amplifiers both variable and fixed. Check results against table of typical sensitivity measurements supplied.

8. Operate fine frequency Autopositioner to 0.0 position, apply 19.5 mc signal to V102 grid (pin #1) and check the sensitivity.

9. Operate fine frequency Autopositioner to 1.9 mc position, apply 21.5 mc signal to grid of V102 and check sensitivity.

(3) R-F Amplifier Grid, First Mixer and H.F. Inductor Alignment

a. Equipment required

1. Signal generator covering frequency range 108 to 135.9

2. Vacuum tube voltmeter.

NOTES: R-F amplifier grid transformer T101 has only one tuned circuit while transformers T102, T111 and T112 each include a primary and a secondary. These circuits are tuned by powdered iron core slugs mounted on a movable table. The alignment consists of positioning the slugs with respect to the position of the slug table. A trimmer capacitor is connected across each winding. These trimmer capacitors are accessible thru openings in the front of the transformers.

b. Procedure

1. Tune transformer T112 first.

2. Operate Autopositioners until combination of indicator readings equals 108.9 mc.

3. Set trimmer capacitors to about one-half capacity (slots in capacitors vertical).

4. Couple vacuum tube voltmeter to grid of V111 (pin #1).

5. Tune slugs in both primary and secondary of T112 for maximum V111 grid voltage.

6. Operate Autopositioners to 134.9 mc and tune trimmer capacitors for maximum V111 grid voltage.

7. Repeat steps 2 through 6 above until it is impossible to obtain any further increase in V111 grid voltage by adjusting the tuning slugs and trimmer capacitors.

8. To align T111 repeat procedure outlined for T112 but instead of tuning for maximum V111 grid voltage, couple the vacuum tube voltmeter to the grid of V102 (pin #1) and adjust slugs and trimmer capacitors in T111 for maximum V102 grid voltage.

9. To adjust T102, operate Autopositioners to 108.9 position.

10. Connect output of signal generator to antenna post.

11. Couple vacuum tube voltmeter to AVC line.

12. Set trimmer capacitors at one-half capacity (slot in capacitor vertical).

13. Tune slugs in primary and secondary of T102 for maximum AVC voltage.

14. Operate Autopositioners to 134.9 mc, tune signal generator to 134.9 mc and tune trimmer capacitors for maximum AVC voltage.

15. Repeat steps 9 through 14 until it is impossible to obtain any further increase in AVC voltage by adjusting the tuning slugs and trimmer capacitors.

16. To align r-f transformer T101, feed a 108.9 mc signal into the antenna circuit as indicated for the alignment of T102 above and with the Autopositioners positioned at 108.9 mc, tune the slug for maximum AVC voltage.

17. Operate Autopositioners and signal generator to 134.9 mc and adjust trimmer capacitor.

18. Repeat steps 16 and 17 until it is impossible to obtain any further increase in AVC voltage.

19. With vacuum tube voltmeter on the AVC line, operate autopositioner to 108.9 position and readjust the slugs in T111 and T112 for increased AVC voltage.

20. Operate autopositioner to 134.9 position and readjust the trimmer capacitors for increased AVC voltage.

21. Repeat steps 19 and 20 until it is impossible to obtain any further increase in AVC voltage.

The above procedures complete the alignment of the r-f section. Check sensitivity and selectivity against table of typical data supplied. Repeat above procedure if sensitivity is low.

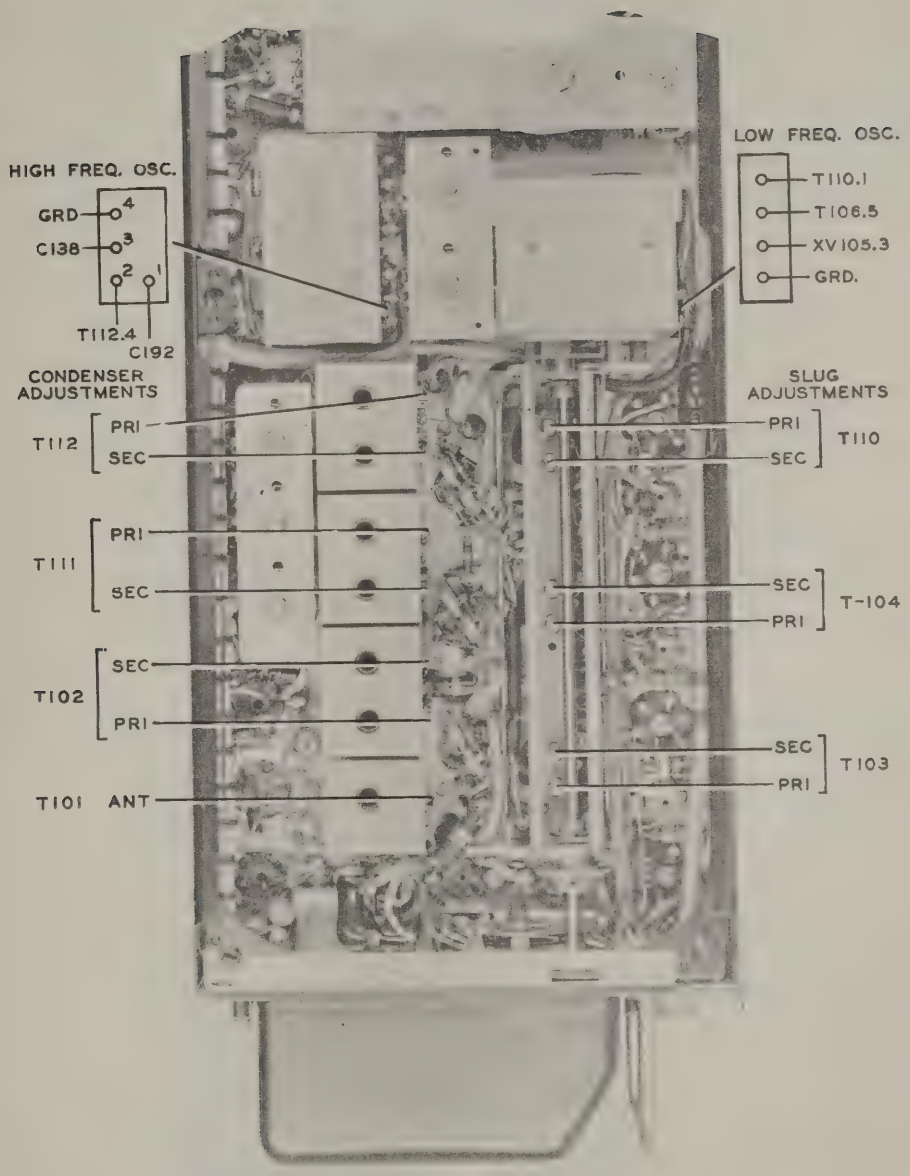


Figure 5-1 Receiver Alignment Points and Oscillator Terminals

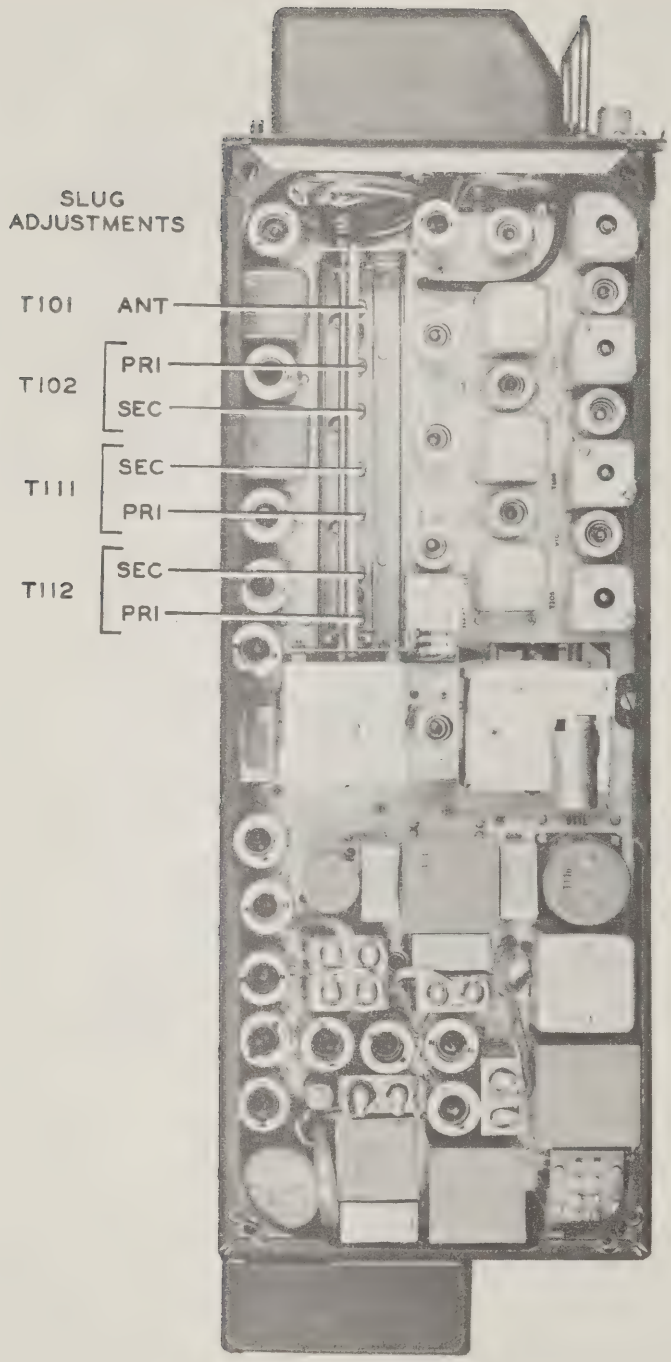


Figure 5-2 51R-2 Receiver Slug Adjustments, Right Side

(b) Trouble Shooting

(1) Servicing R-F Transformers T101, T102, T111 and T112. Some of the components within these transformer assemblies can be replaced by simply removing the shield can. The replacement of others requires the removal of the transformer from the receiver chassis. Steps a. and b. of the following procedure outline a method of gaining access to the components that are accessible for servicing when the shield is removed. Steps c. thru g. outline the procedure for the removal of the transformer from the chassis.

a. Remove nuts from studs and lift off shield.

b. Remove second set of nuts and lift off Bakelite plate.

c. Unsolder the connections to the transformer.

d. Using a Spintite wrench, remove the nuts from the studs that protrude thru the chassis and slug table frame.

e. Lift the transformer straight upward, being careful to lift the assembly clear of the slugs before removing it in any direction other than upward. Remove the Bakelite plates from the top and bottom of the transformer to gain access to components within the assembly.

f. To replace broken tuning slugs, rotate the broken slug stud clockwise until the slug and stud drop down thru the hole in the top of the transformer. Insert a new slug thru this same hole and while holding the slug stud against the movable table with a small round rod, use a screwdriver to rotate the slug counterclockwise until the threads catch.

g. Check the slug table spring tension by selecting 134 mc (the slug table in extreme upward position) and checking to be certain that the rollers are tight against the cams. They must be tight enough so that vibration will not cause the slug table to move and as a result change the positions of the slugs in the coils.

(2) H-F Injection Oscillator Servicing. To remove the high frequency injection oscillator for servicing, proceed as follows.

a. Unsolder the four leads from the oscillator. These soldered connections are located on the underside of the chassis.

b. Using a Spintite wrench, remove the three nuts from the studs that mount the oscillator on the slug rack.

c. Move the oscillator toward the rear of the receiver until the crystal selector switch is disengaged from the drive shaft. A flattened portion on the end of the shaft fits into the rotor of the switch in the oscillator.

d. Lift the oscillator assembly from the chassis.

e. Removing the portion of the oscillator enclosure that is opposite the side upon which the tube socket is mounted, will expose all oscillator components for repair or replacement.

f. When replacing the h-f injection oscillator, it is very important to properly synchronize the crystal selector switch with location of the slug rack.

g. To synchronize the switch, select 124 mc with the Autopositioner and set the crystal selector switch (before installing the oscillator) by checking continuity between crystal socket number 9 and terminal number 1 (grid #1) on the oscillator tube. Slide the oscillator assembly into place and carefully insert the end of the shaft into the switch rotor. Insert the ends of the studs into the holes in slug rack and tighten nuts.

h. With ohmmeter set as in step (g), insert crank on front panel and manually close the megacycle autopositioner. Turn crank clockwise until the ohmmeter shows open circuit. This should be between 5 and 6 turns of the crank.

i. If the ohmmeter does not show open circuit between 5 and 6 turns, follow steps j, k, l, m, and n.

j. Turn power on and reselect 124 mc.

k. Turn power off and insert crank. Manually close the megacycle autopositioner by pressing armature of the relay until pawl is out of stop wheel. Turn crank 5/2 turns.

l. Loosen both set screws on oscillator switch adapter. With the autopositioner left as in step k, looking toward the rear plug, transformer side of the radio up, rotate the oscillator switch adapter through the contact counterclockwise.

m. Then rotate shaft clockwise until contact just breaks, and tighten set screws.

n. Recheck steps h and i.

(3) L-F Injection Oscillator Servicing. To remove the 1-f injection oscillator from the receiver for servicing, proceed as follows.

a. Remove the tube shield and tube from the oscillator.

b. Remove the nuts from the studs that protrude through the oscillator mounting plate. One of the studs is located above the receiver chassis and the other located beneath the chassis.

c. After the nuts have been removed from the studs, move the oscillator toward the rear of the receiver as far as possible (until the studs clear the mounting plate) and move it through the opening in the chassis toward the side of the chassis upon which the 1-f injection oscillator tuning plug table is mounted. When the crystal compartment cover clears the receiver chassis, move the assembly farther toward the rear of the receiver and lift it out.

d. Unsolder the leads from the oscillator connector strip. Oscillator components and crystals are accessible when the covers are removed from the front and rear of the oscillator.

IMPORTANT

The synchronization adjustments of the 1-f oscillator are extremely critical and the procedure outlined below should be carefully followed to obtain proper adjustment of the tuning rack and oscillator selector switch.

e. By checking continuity between ungrounded contact of crystal position and pin #1 of oscillator tube, rotate the crystal selector switch until the switch is in the position that selects crystal #15 (0.0 mc).

f. Step the autopositioner around until the index plate indicates 0.0 mc.

g. With the flexible coupler loosened, manually rotate the shaft that drives the cams until the edge of the movable section of the rack is resting on the lowest portion of the cams, next to the portion of the cam that rises sharply, to the highest point. Then tighten set screws on coupler.

h. Insert the flattened end of the stub shaft into the crystal selector switch rotor and secure the oscillator assembly to the mounting plate.

i. Insert crank and close the 0.1 mc relay armature manually until pawl is lifted out of stop wheel slot. Turn crank clockwise until ohmmeter shows open circuit. This should be between 5 and 6 turns of the crank.

j. If the ohmmeter does not show open circuit between 5 and 6 turns, follow k, l, m, n, o, and p.

k. Select a frequency so that both set screws are available on the slug table gear. This should be 0.0 mc position, however, if it isn't, the table in step (1) will identify frequency vs. slug table.

l. Connect an ohmmeter from the ungrounded contact of the crystal position selected in step 8. The following table will show the crystal selected for each position of 0.1 mc positioner.

Pos. No.	Freq. of Autopositioner
15	0.0
16	0.1
17	0.2
18	0.3
19	0.4
20	0.5
21	0.6
22	0.7
23	0.8
24	0.9
25	1.0
26	1.1
27	1.2
28	1.3
29	1.4
30	1.5
31	1.6
32	1.7
33	1.8
34	1.9

m. Insert crank and close the 0.1 mc relay manually. Turn crank clockwise 5-1/2 turns.

n. Loosen both set screws on slug table gear.

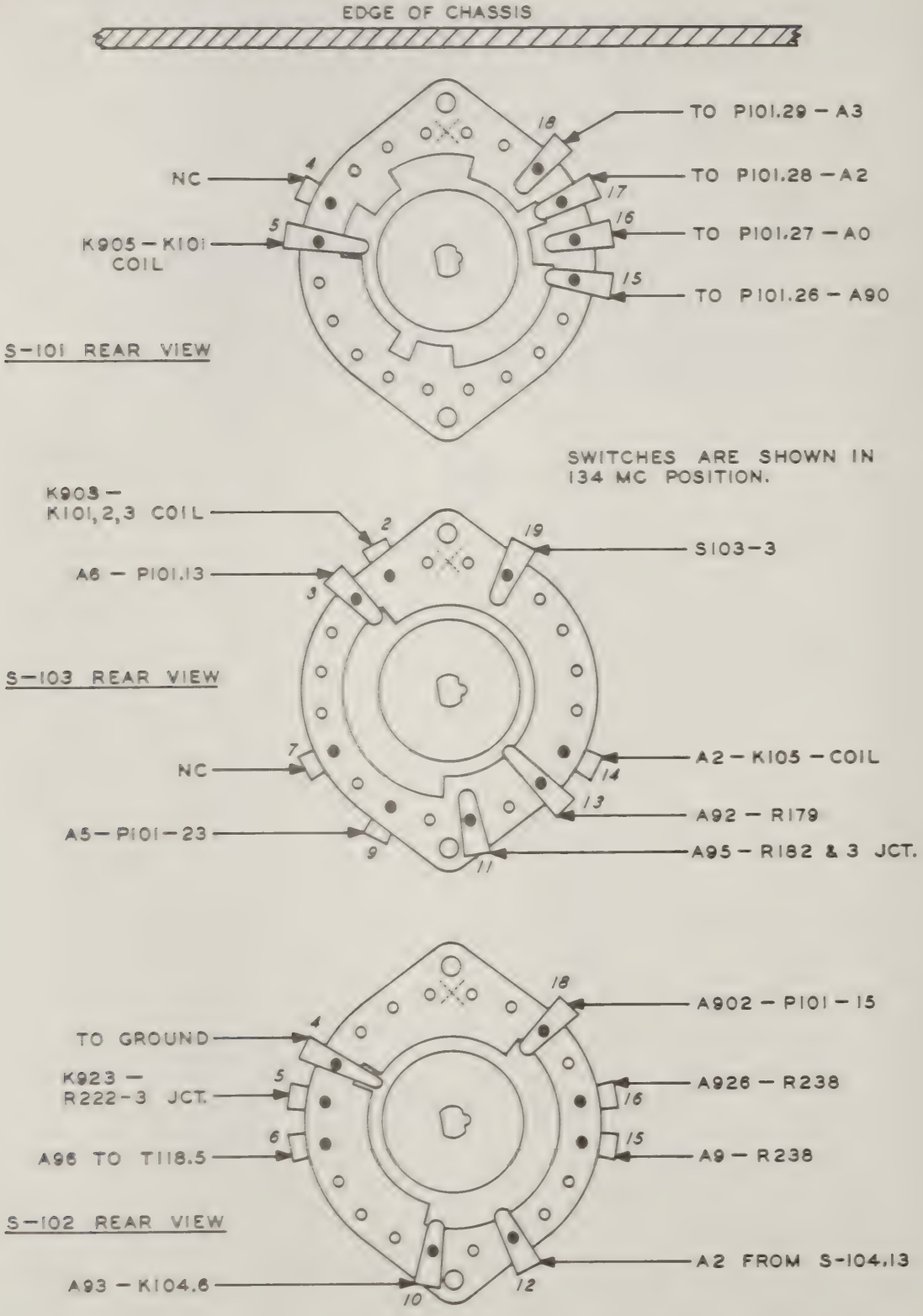
o. Then rotate the gear in a clockwise direction until the ohmmeter shows a short circuit. Very slowly rotate the gear in a counterclockwise direction until the circuit just breaks.

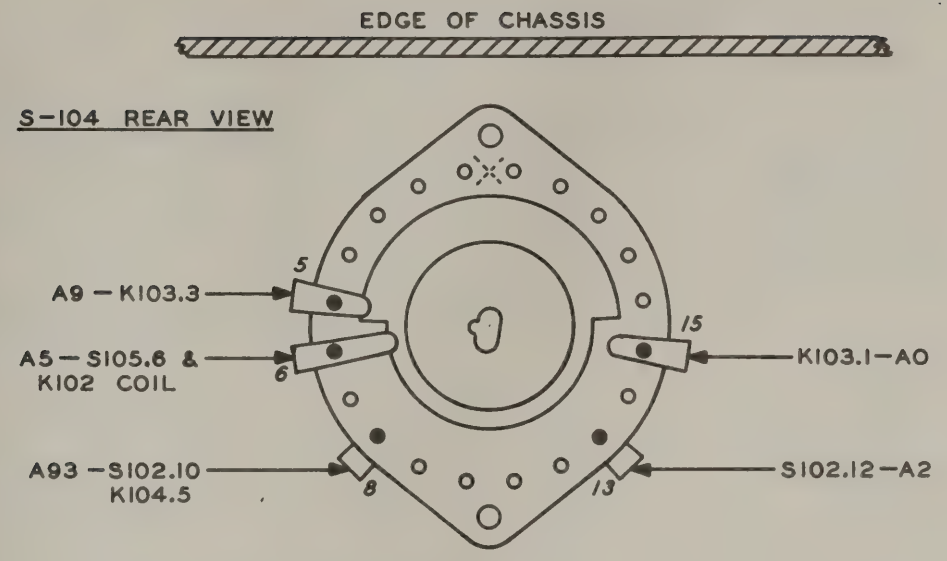
p. Holding the gear firmly in the position determined in step 13, tighten both set screws.

q. Recheck by doing steps m and n.

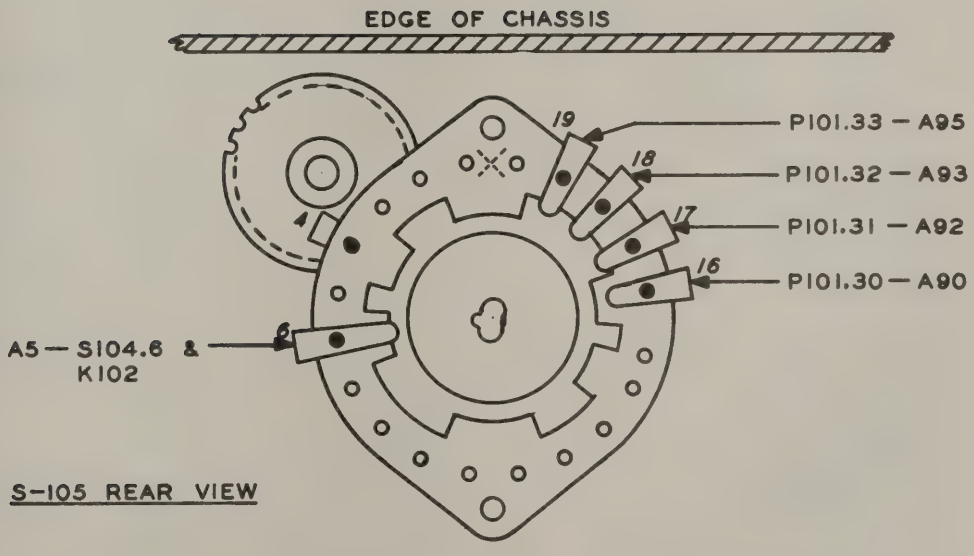
(4) Autopositioner and Receiver Control Switches. Switches S101, S102, S103, S104 and S105 are located behind the front panel. The best switches available have been used and very little trouble should be experienced with these switches. However, if a switch becomes jammed or a contact does not close, the following information may aid in checking continuity and in locating the defective contact.

A. SWITCH CONTACT LOCATION.





SWITCHES ARE SHOWN IN
0.0 MC POSITION.



b. Auxiliary Switching Continuity Checks.

S102 (Left Side Receiver, 3rd from Panel)

MEGACYCLES	Front Side: RCI Disabling Circuit Clips 5 & 6 Connected together at:	Front Side: Phase Localizer Sensitivity Clips 15 & 16 Connected together at:	Rear Side: Terminal 4 Ground Common — Clip 10 Modulation Index Grounded at:	Rear Side: Terminal 4 Ground Common — Clip 12 Modulation Index Grounded at:	Rear Side: Terminal 4 Ground Common — Clip 18 Ambiguity Disabling Grounded at:
108 109					X
110 111				X	X
112 113	X	X	Connected To Clip 8 on S104	Clip 12 Wired to Clip 13 on S104	
114 115	X	X			
116 117	X	X			
118 119	X	X	X		
120 121			X		
122 123			X	X	X
124 125			X	X	
126 127			X	X	
128 129			X	X	
130 131			X	X	
132 133		X	X	X	
134 135		XX	X	X	X

S103 (Left Side Receiver, 2nd from Panel)

MEGACYCLES	Front Side			Rear Side	
	(Clip 2 = + 28 Volts)			(Clip 13 - Common, Audio Input)	
				Acts as Single-Pole, Double Throw Switch, changing at 112 MC	
	Clip 7 Alternate Antenna Relay Energized + 28 Volts at:	Clip 9 Antenna Relay Energized 28 Volts at:	Clip 14 Phase Tone Relay Energized + 28 Volts available at:	Clips 3 & 19 wired together connected to Audio at:	Clip 11 connected to Audio at:
108 109			X		X
110 111			X		X
112 113	Alternate Connector not used at present.			X	
114 115				X	
116 117				X	
118 119	X			X	
120 121	X			X	
122 123	X	X		X	
124 125	X	X		X	
126 127	X	X		X	
128 129	X	X		X	
130 131	X	X		X	
132 133	X	X	X	X	
134 135	X	X	X	X	

S-104 (Right Side Receiver, Next to Panel)

Front Side - Clip 8 connected to Clip 10 on S102, Common, Modulation Index Clip 13, wired to Clip 12 on S102, connects with Clip 8 at:

Rear Side -
Fine Frequency Tuning -
Distinguishes even MC from odd MC

0.0 .1 .2 .3 .4 .5 .6 .7 .8 .9	Clip 8 is grounded thru S-104 and S-102, working in series, for 111.0 - 111.9 MC (and for all the Odd Megacycles from 123 to 135 Inc.) However, Clip 10 on S-102 is grounded throughout 118 - 135 Inc.	(0.0 - 0.9)--(1.0 - 1.9) - On Fine Freq. Shaft (Autopositioner Operation in conjunction with S-105)
1.0	X	
1.1	X	
1.2	X	
1.3	X	
1.4	X	
1.5	X	
1.6	X	
1.7	X	
1.8	X	
1.9	X	

5.1.2. INSTRUMENTATION CIRCUITS.

(a) Voltage and phase angle measurements. - See Table 5-7 of paragraph 5.4.

(b) Test Equipment Calibration.

(1) Preliminary.

a. The following procedure presupposes that it is desired to set up the 479S-1 Test Equipment so as to make available standard signals of three types, VOR, Phase Localizer, and Tone Localizer, without readjustment, when changing signals.

b. Three modulation levels are involved in this procedure; 30%, 20% and 7.5%; and it is essential that Boonton modulation meter readings for these levels be known. Thirty percent is full scale on the B meter range and may be depended upon to be accurate. Similarly, the 20% reading will be sufficiently accurate on the meter. However, 7.5% corresponds to a rather small reading on the modulation meter and could be subject to wide inaccuracy. Therefore, the 211-A 7.5% point should be calibrated in advance of 479S-1 calibrations.

c. To find the meter reading for 7.5%, plug into the external modulation jack of the Boonton, a 30 cycle signal (30 cycle variable phase on test signals switch position is a good source to use) of such a level as to modulate the 211-A 30% as indicated on the B meter scale. Using a 4 to 1 pad of total value about 10,000 ohms or applying an input of 1/4 of the voltage required for 30%, as read on a meter of constant accuracy, establishes the 7.5% modulation point on the 211-A meter. This point should be noted for future reference.

Signal levels are variable on Calibrate position by means of the screwdriver adjustment, behind the access door on the 479S-1 front panel. Once set, these levels remain constant and need be checked only occasionally. For variable output levels in special testing work, the test signals position and master gain control should be used. Use of this control does not disturb the Functions calibration.

(2) CALIBRATION OF VOR SIGNALS.

a. Normal VOR modulation consists of 30% 9960 cps FM and 30% 30 cps rotatable in phase angle with respect to the 30 cps derived from the 9960 FM. These two 30 cps voltages are in phase on a radial emanating on a magnetic north bearing from the station.

b. Proper Adjustment of Modulation.

1. Set Functions selector at Calibrate and Test Signals selector at 30 cycles variable phase. Set variable phase output to 1.0 volt on

output meter M101. Set 211-A gain control to achieve 30% modulation or full scale on B range.

2. With Function selector as in 1, set Test Signals selector to 9960 FM. Adjust 9960 FM level to 30% modulation by screwdriver control leaving Boonton modulation control as in 1 above. This gain control setting on the 211-A is fixed in 1 for all functions and should not require readjustment. On 9960 FM, the output meter will read approximately 0.9 V for 30% modulation.

3. Next switch the 211-A Modulation Meter to the A scale and Function Selector to the Omni-Range position. The 211-A Modulation Meter will not necessarily indicate 60% for the addition of the two 30% modulations.

4. At zero degrees the VOR information obtained from the 479S-1 when adjusted as outlined herein, corresponds to the information that an aircraft would pick up when in a position magnetic north of the station. In such a position on an outbound course, the receiver if properly oriented will read zero degrees From on the Deviation Indicator, 180 Degrees on the OBI dial, and 180 degrees on the RMI needle.

(3) Calibration of Phase Localizer Signals.

a. Normal Phase Localizer signals consist of 30% 9960 and 0% 30 cps when on course. When off an inbound course 2-1/2 degrees to left, 7-1/2% modulation at 30 cps in phase with the modulation on the 9960 should give a 90 microampere Deviation Indicator deflection to the right.

b. Proper Adjustment of Modulation.

1. 9960 FM setting as outlined for VOR operation in (2), b., 1. is suitable for phase localizer operation and should not be changed.

2. Observe 7.5% modulation reading as outlined in "Preliminary."

3. Rotate Test Signal selector to 30 cps Reversible Phase and set Localizer Differential attenuator to -4 db. Adjust R135 until the 7.5% indication obtained in 2, is duplicated. (This should occur with an M101 reading of approximately 0.25 V.) The 479S-1 output with the Differential Attenuator centered should be 2 millivolts or less. This voltage will be made up principally of stray 9960 plus some 60 cps and a small amount of 30 cps in quadrature to the desired 30 cps phase localizer signal. This residual should be in the order of 20 db below the desired 30 cps level obtained at the 1/2 db point on the Differential Attenuator.

4. The criterion for balance on Phase Localizer is taken as minimum (Reversible phase) voltage on course. Control R137 is used to achieve

this minimum. A secondary check can be had by observing equality of amplitude at the ±4 db position of the Differential Attenuator (R161).

(4) Calibration of Tone Localizer Signals.

a. Normal on course modulation consists of 20% of 90 cps and 20% of 150 cps.

b. Proper Adjustment of Modulation.

1. Set the Function Selector on Calibrate and the Test Signals selector on 90-150. Adjust the differential attenuator to "Cal 90."

2. With signals established as in 1, and the 211-A Modulation Control set approximately mid-range adjust R133 until the Modulation Meter indicates 20% on the B range. Disconnect plug from 211-A modulation input and read amplitude using a Ballantine or equivalent rms meter (this should be approximately 0.66 V.)

3. Set Differential Attenuator to "Cal 150." Adjust R134 until this amplitude corresponds exactly to that noted in 2.

4. Reconnect plug to 211-A modulation input and set Function Selector to Tone-Localizer position.

5. It should be noted that the preceding method is least affected by harmonics since it is based on RMS readings. Meter M101 (average reading) and the BRC modulation meter (peak reading) can also be used but are inherently more susceptible to error due to small percentage harmonics; They are best suited to daily monitoring of the 90-150 levels.

(5) Adjustment of 1000 cps Oscillator.

a. The purpose of this facility is to provide 1000 cps at audio frequency and 500 ohm output (the 211-A provides both 400 and 1000 cps as modulation on the selected carrier frequency).

b. Set the Function Selector switch at Calibrate position and the Test Signals switch to 1000 cps position. Adjust R158 to give a 1.0 V indication on M101. For a variable amplitude at 1000 cps set Function Selector to Test Signals and use Master Gain Control.

c. Typical Phase Angle Observation - 51R-2 Receiver.

5.1.3. TUNING MECHANISM.

(a) Lubrication. - It is recommended that a small amount of the following lubricants be used on the tuning mechanism in the receiver:

(1) Gear Train - A small amount of AN-G-25 Grease applied to all gears in the train.

(2) Pawl Pivot - A drop of AN-O-4.

(3) Shaft Bearing - A drop of AN-O-4.

(b) Motor Repair. - The motor is mounted on the front of the receiver with the commutator end farthest from the receiver panel. The brushes are covered by an end bell that fits over the protruding end of the motor.

(1) Replacement of Brushes. - When brushes are worn to less than one-fourth inch in length they should be replaced with new brushes.

a. Remove end bell.

b. Unsolder the leads to the brushes.

c. Lift the spring off the brushes and remove the brushes from the holders.

d. Replace with new brushes and reverse the procedure given in steps a., b., c. above.

(2) Replacement of Armature or Armature Bearings.

a. Unsolder brush leads and power leads from motor.

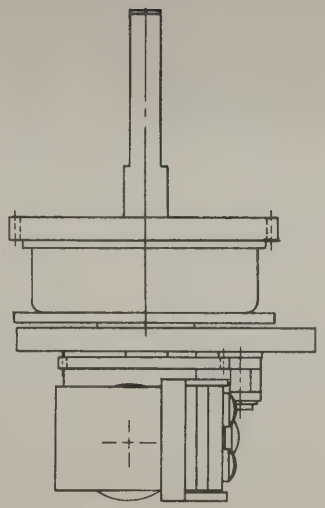
b. Remove brushes as outlined above under (1) Replacement of Brushes.

c. Remove end frame mounting screws and brush retaining spring studs.

d. Remove end frame.

e. Pull out armature and bearings.

f. Obtain new bearings, new armature or armature and bearing assembly and replace in motor. Be sure that the gear on the end of the armature shaft engages the drive gear in the receiver when the armature is inserted into the motor assembly.



NOTES:

1.. PLACE PAWL (P) ON PAWL STUD ON PLATE (A) AND SECURE WITH RETAINING RING (R)..

2.. INSERT SHAFT ASY.. (K) THRU BEARING IN PLATE (A) AND APPLY ONE DROP OIL (AN - O - 4) TO BEARING..

3.. ADD INDEX FLANGE (N), CLUTCH DRUM (E), CLUTCH FLANGE (C), AND START NUT (F) ON THREADS OF SHAFT..

4.. TURN SHAFT TO POSITION SHOWN AND ENGAGE PAWL (P) IN CORRESPONDING NOTCH OF STOP WHEEL.. TURN INDEX FLANGE (N) TO EXPOSE PROPER NUMBER IN NOTCH OF PLATE (A).. TIGHTEN NUT (F) TO CLAMP CLUTCH DRUM AND FLANGES..
NOTE: HOLD SHAFT BY FLATS WHILE TIGHTENING NUT; DO NOT APPLY TORQUE TO STOP WHEEL AND PAWL..

5.. PLACE CLUTCH SPACER (D) AND CLUTCH ASY.. (L) IN CLUTCH DRUM AND INSERT TWO CLUTCH SPRINGS (M)..

6.. INSTALL ONE RETAINING RING (J) NEXT TO NUT (F), WITH SHARP EDGE TOWARDS NUT..

7.. PLACE CLUTCH GEAR ASY.. (H) ON SHAFT AND INSTALL SECOND RETAINING RING (J) WITH SHARP EDGE TOWARDS GEAR.. APPLY ONE DROP OIL (AN - O - 4) TO BEARING IN GEAR..

8.. TEST CLUTCH TORQUE AT 30 RPM AFTER RUNNING - IN CLUTCH AT LEAST 200 REVOLUTIONS.. IF NECESSARY, CHANGE SPRINGS TO BRING TORQUE WITHIN SPECIFIED LIMITS OF 4 TO 5 1/2 INCH - LBS..

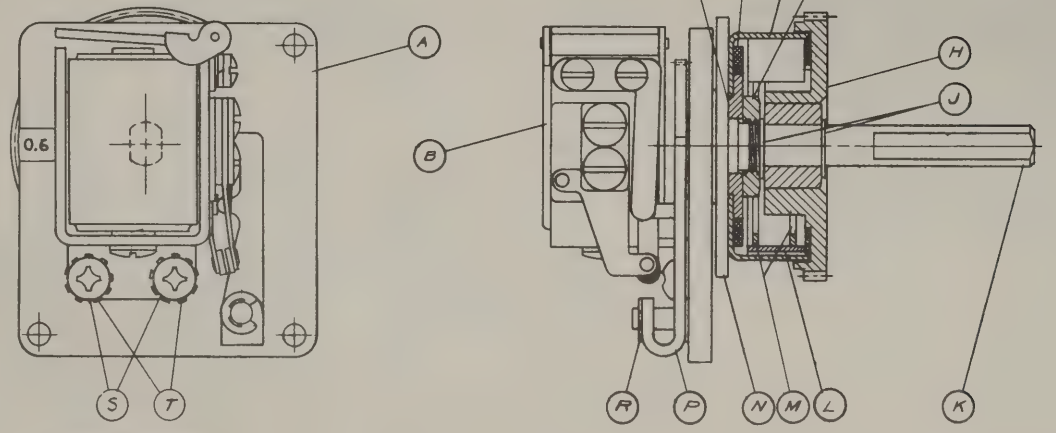
9.. PLACE RELAY (B) IN POSITION, WITH PROJECTION OF PAWL (P) ENGAGED BETWEEN ARM AND SPRING OF RELAY; AND START TWO SCREWS (S) WITH SHAKEPROOF WASHERS (T)..

10.. ADJUST POSITION OF RELAY WITHIN LIMITS OF MOUNTING - HOLE CLEARANCE SO THAT RELAY ARM IS AGAINST SIDE OF RELAY FRAME WHEN PAWL (P) IS FULLY SEATED IN NOTCH.. TIGHTEN RELAY MOUNTING SCREWS..

11.. DEPRESS RELAY CLAPPER AND CHECK THAT PAWL CLEARS STOP WHEEL TO ALLOW FREE ROTATION OF SHAFT.. IF PAWL DOES NOT CLEAR, RE - CHECK DE - ENERGIZED POSITION (NOTE 10), AND ADJUST RELAY AIR GAP IF NECESSARY SO THAT PAWL CLEARS STOP WHEEL BY ABOUT 1/64"..

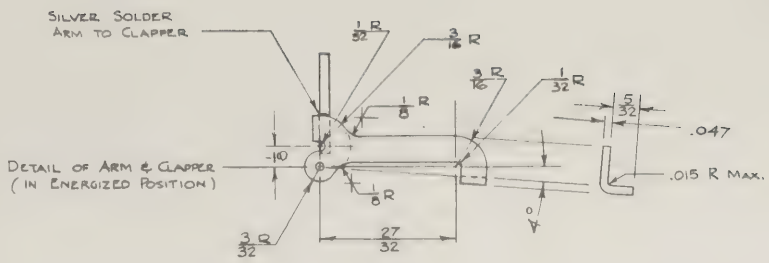
QUANTITIES LISTED ARE FOR ONE ASSEMBLY					
503 7092 003	503 7093 003	ITEM NUMBER	PART NUMBER	PART NAME
1	1	A	503 7090 002	..PLATE ASY..
1	1	B	· 503 5115 003	..RELAY
1	1	C	· 503 4920 001	..CLUTCH FLANGE
1	1	D	· 502 1164 002	..CLUTCH SPACER
1	1	E	· 502 1132 002	..CLUTCH DRUM
1	1	F	· 334 0249 00	..NUT
1	1	H	503 7091 002	..CLUTCH GEAR ASY..
2	2	J	· 340 0025 00	..RETAINING RING
1	1	K	503 7088 001	..SHAFT ASY..
1	1	L	· 502 1825 002	..CLUTCH ASY..
2	2	M	· 502 7029 002	..CLUTCH SPRING
	1	N	503 4924 001	· MC INDEX FLANGE
1		N	· 503 4923 001	· TENTH MC INDEX FLANGE
1	1	P	· 503 5079 002	..PAWL
1	1	R	· 340 0087 00	..RETAINING RING
2	2	S	343 0166 00	6 - 32 X 3/16 SCREWS
2	2	T	373 8020 00	NO..6 SHAKEPROOFS

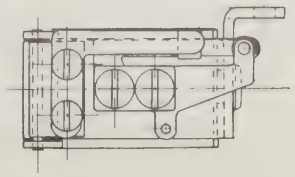
DETAIL
AUTOPOSITIONER HEAD
TYPE 380A - 1
WITH MEGACYCLE INDEX
FLANGE (503 4924 001)

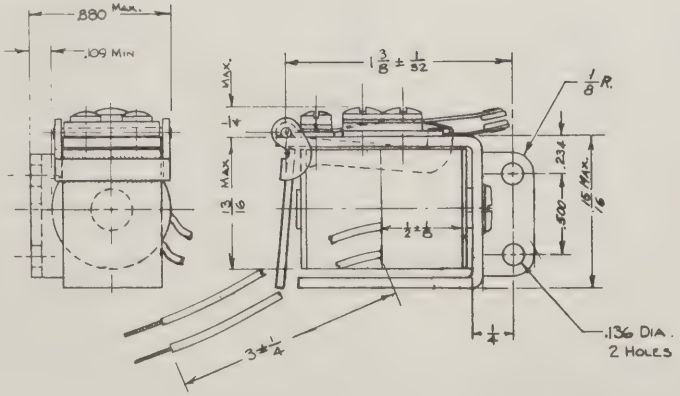


AUTOPOSITIONER HEAD
TYPE 380A - 2
WITH TENTH MEGACYCLE
INDEX FLANGE (503 4923 001)

Autopositioner Relay Details







RELAY IN DE-ENERGIZED POSITION

RELAY NOTES:

1.. RELAY FRAME, CONTACTS, AND COIL DIMENSIONS ARE SIMILAR TO RELAY 502 1901 003..

2. COIL OPERATING VOLTAGE: 26.5 V.D.C. NOMINAL, 32 V.D.C. MAXIMUM, 18 V.D.C. MINIMUM..

3. CONTACT: SINGLE CONTACT, NORMALLY OPEN.

4.. CONTACT RATING: SHALL MAKE AND CARRY 10 AMPS, 32 V.D.C.. INDUCTIVE CIRCUIT OF 5 W.H.. AS MEASURED AT 1000 C.P.S..

5.. PROJECTING ARM PULL - IN FORCES: 12 OZ.. MIN.. AT 18 V.D.C.. WITH RELAY AT ROOM TEMP., 8 OZ.. MIN.. AT 18 V.D.C.. AFTER 1 HOUR ON DUTY CYCLE AT 80° C. AMBIENT..

6.. PROJECTING ARM TRAVEL: .060 ± .010 TOTAL TRAVEL, MEASURED AT END OF ARM; .035 MAX.. TRAVEL BEFORE CONTACTS ARE CLOSED.

7.. RELEASE TIME: .005 SECONDS MAX.. FROM INSTANT COIL VOLTAGE IS REMOVED TILL CONTACTS BREAK..

8. FREQUENCY OF OPERATION: 4 PER MINUTE MAX..

9. DURATION OF OPERATION: 5 SECONDS MAX.

10.. VIBRATION: THE CONTACTS AND THE PROJECTING ARM SHALL MAINTAIN THEIR PROPER POSITION WHEN THE COIL IS EITHER ENERGIZED OR DE - ENERGIZED AND SUBJECTED TO MECHANICAL FREQUENCIES OF 10 TO 60 CYCLES PER SECOND AT 0.03" AMPLITUDE (0.06" TOTAL EXCURSION)..

11.. MATERIALS: PHENOLIC GRADE LTS - E - 2 OR BETTER IN ACCORDANCE WITH LATEST VERSION OF JOINT ARMY - NAVY SPECIFICATIONS JAN - P - 13.. MATERIALS USED SHALL BE FUNGI RESISTANT, OR RELAY SHALL BE TREATED TO RENDER IT FUNGI RESISTANT, IN ACCORDANCE WITH LATEST VERSION OF SIGNAL CORPS SPECIFICATION 71 - 2202 a.

12.. FINISH: THE ENTIRE ASSEMBLY SHALL WITHSTAND A 200 HOUR SALT SPRAY TEST IN ACCORDANCE WITH ARMY - NAVY AERONAUTICAL SPECIFICATION AN - QQ - S - 91 WITHOUT IMPAIRING OPERATION AND NO PART SHALL SHOW EVIDENCE OF APPROACHING FAILURE CAUSED BY CORROSION..

13.. MARKINGS: PERMANENTLY MARK PART NUMBER, COIL VOLTAGE, AND MANUFACTURER'S NAME ON RELAY..

14.. HINGE PIN SHALL BE OF PHOSPHOR BRONZE, UNPLATED..

15.. MINIMUM CONTACT PRESSURE SHALL BE 28 GRAMS..

16.. CONTACT SURFACES SHALL BE VERY SMOOTH OR BURNISHED, AND FREE OF SOLDER, PLATING, OR FOREIGN SUBSTANCES..

17.. OPERATING TEMPERATURE: -55° C.. TO 80° C.. AMBIENT TEMPERATURE..

18.. MAXIMUM TEMPERATURE RISE ABOVE 80° C AMBIENT SHALL NOT DAMAGE RELAY OR IN ANY WAY IMPAIR ITS PERFORMANCE.

19.. THE RELAY SHALL MEET ALL REQUIREMENTS WHEN OPERATED AT BAROMETRIC PRESSURES RANGING FROM 5.54" TO 30" OF MERCURY WITH MAXIMUM VOLTAGE OF 32 V.D.C.. APPLIED ACROSS THE CONTACTS.. THE RELAY CONTACTS SHALL SHOW NO EVIDENCE OF MECHANICAL OR ELECTRICAL FAILURE WITH THE ABOVE CONDITIONS..

20.. THE RELAY SHALL BE SUBJECTED TO 95% RELATIVE HUMIDITY (± 5%) AT 50° C (± 5°) FOR 72 HOURS.. IT SHALL BE CAPABLE OF OPERATION AT ANY TIME UNDER THE WORST CONDITIONS AND AT THE END OF THE PERIOD.. IT SHALL SHOW NO EVIDENCE OF UNDUE CORROSION OR APPROACHING MECHANICAL OR ELECTRICAL FAILURE..

21.. FORCE ON ARM REQUIRED TO MOVE CONTACT ARM WITH RELAY DE - ENERGIZED SHOULD BE 42 GRAMS MINIMUM..

22.. VOLTAGE BREAKDOWN: RELAY SHALL WITHSTAND 600 V.A.C.. APPLIED ACROSS FRAME AND LEADS AFTER MAX.. TEMPERATURE RISE..

(c) Autopositioner Repair and Adjustment. - To operate the receiver without a control unit, press the clappers on the relays on the Autopositioners to stop the mechanism around to the desired positions. The index plate on the Autopositioner indicates frequency. The sum of the readings on the two Autopositioners gives the frequency to which receiver is tuned. With relay K103 in its normal position (not energized) stepping the Autopositioners around by pressing the relay clappers, selects only even frequencies; that is, 108 mc, 110 mc, 112 mc, etc. To select odd frequencies, 109 mc, 111 mc, 113 mc, etc., hold relay K103 operated by inserting a piece of folded paper between the clapper and the stop.

(1) Autopositioner Relay Adjustment. - When it becomes necessary for any reason to remove the Autopositioner operating relay, K101 or K102, the following procedure should be followed to realign the relay:

a. Loosen relay mounting screws.

b. With pawl engaged in one of the notches of the stop-wheel hold pawl fully seated in notch.

c. Rotate the relay clockwise about the mounting screws so that the relay frame and armature contacts the pawl projection to eliminate all lost motion in the relay.

d. Tighten relay mounting screws in this position.

In addition, the following checks may then be made to check adjustment of the relay travel and contact spacing:

e. Depress the relay clapper and check to see that pawl lifts clear of notch to allow free rotation of the stop wheel. Pawl should clear stop wheel teeth by about 1/64". More than about 1/32" clearance indicates excessive relay travel with a corresponding loss of power. Relay travel can be adjusted, if necessary, by loosening the two screws near the relay hinge and sliding the hinge plate up or down slightly as required.

f. The motor operating contacts on the relay should be adjusted to maintain contact when the pawl is resting on top of a stop wheel tooth between positions with the relay de-energized. This is to insure that the motor will continue to drive until the pawl engages the proper notch, which opens the contacts by at least .025". Contacts can be adjusted, if necessary, by bending the stationary contact arm.

(2) Removal of Autopositioner for Servicing.

a. To remove the megacycle Autopositioner from the receiver, loosen the coupler (end of coupler nearest switch) that couples the Autopositioner to the tuning rack, loosen the mounting screws that hold the Autopositioner to the front panel and lift the mechanism from the receiver.

b. To remove the tenth megacycle Autopositioner from the receiver, loosen the coupler, loosen the set screw in the gear behind the panel, loosen the screws that secure the Autopositioner to the front panel and lift the mechanism from the panel.

(3) Clutch Maintenance.

a. To gain access to the clutch, remove the Truarc retaining ring using the Truarc pliers and slide the gear off the shaft.

b. To remove the clutch from the drum, press the ends of the clutch toward each other, using wire bending pliers, and slide the clutch out of the drum.

c. To remove the clutch drum from the shaft, remove the Truarc ring with a Truarc pliers and while holding the shaft, (do not use pawl to hold shaft) loosen the nut with pliers or wrench and proceed to slip the spacer and drum from the shaft.

d. Before replacing the clutch ring in the drum, carefully wipe the inside the drum to remove oil and grease and inspect the drum surface for scoring.

e. Lubricate the oilite bearing in the mounting plate with a drop of AN-O-4 oil.

f. The number of metal springs within the clutch shoe and the resilience of the metal springs determines the torque of the clutch. New springs may be required from time to time. Each Autopositioner must have 4 1/2 inch pounds of torque in order to function properly.

g. To reset the index plate after having loosened or removed the clutch drum, assemble the Autopositioner up to the point of tightening the nut that secures the clutch drum and index plate, rotate the shaft until the flat on the shaft is opposite the notch in the mounting plate, rotate the index plate until the plate indicates "112" if working on the megacycle Autopositioner or "0.6" if working on the tenth megacycle Autopositioner and tighten the nut.

h. Reassemble the Autopositioner and make adjustments of relays as outlined above.

(e) Assembly Precautions:

(1) The following notes on drawing 503 5115 003 (facing page 5-19 in Instruction Book) are probably the major ones to check on individual relays:

Relay Notes (5) - Pull in force at room temperature.
(6) - Travel and contact spring.
(15) - Contact pressure.
(16) - Contact surface finish.
(21) - Spring force.

(2) Adjustment of relay during assembly of Autopositioner head is outlined on drawing 503 7092 003 (opposite 503 5115 003 in Instruction Book). Special attention should be given the following notes shown on this drawing:

Note (1) Place pawl on stud, etc. (At this point the pawl should be checked for free fit on the stud and for a minimum of about .002 end play with the retaining ring in place).

Note (2) Insert shaft assembly, check. (Here the pawl should be checked for proper engagement with the stop wheel notch. It should fit into the notch full depth with from .000" to .007" clearance).

Note (8) Clutch torque.

Note (9) Place relay in position, etc. (The relay should be placed to engage the pawl finger without bending the relay spring. This can be done by hooking the pawl finger under the middle of the spring and sliding the relay upward to engage the finger between the spring and relay arm. The spring should not be pulled back beyond its normal operating travel).

Note (10) and (11) Relay adjustment and alignment.

(3) Synchronization of switches can be done by visual inspection. Alignment is not critical, but the switches should be positioned so that the blade segments are well centered on the switch positions. The unit should be run under power and each switch stack checked at several positions to eliminate any errors caused by backlash and eccentricity.

(4) Alignment of the Autopositioner heads on the 51R panel, as well as freedom of the gearing, is checked before the panel is assembled to the chassis. However, attachment of the chassis and especially of the wraparound may cause the Autopositioner shafts to bind due to warping of the panel.

With the switches and slug racks in place, it is difficult to check the Autopositioner shaft for free play in its bearings. It may be necessary to check the entire drive for available torque by some means such as a clamp-on "prony brake." Such a test should indicate a stall torque not less than 1-1/2 in-lbs when the tuner shaft is in the position of maximum shaft load.

(f) Adjustment Procedure:

If it is necessary to replace an autopositioner relay or to realign it for any reason, the following procedure should be followed:

(1) Seat pawl in a notch of the stop wheel. Turn the gear train by hand to allow the pawl to seat fully.

(2) Place relay so that the pawl finger comes between the relay spring and frame at about the middle of the spring.

(3) Line up the mounting hole farthest from the pawl and start this mounting screw, without applying any pull to the relay spring (let the relay turn clockwise slightly).

(4) Turn the relay counterclockwise about this screw, which will let the pawl finger slide between the spring and relay arm. Start the second screw.

(5) Hold the pawl fully seated in the stop wheel notch and hold the relay frame against the pawl finger. Tighten mounting screws. Check that pawl is fully seated and that the relay clapper and arm have no appreciable free play. Reposition relay if necessary to meet these conditions.

(6) Depress the relay clapper and turn the autopositioner manually or under power and check the clearance between the pawl tip and stop wheel. This should be approximately 1/64" or less. If adjustment is required, loosen the two screws near the hinge point and slide the hinge plate up or down as required. (Adjustment may be aided by placing a .020" feeler gage between the clapper and coil core.) Be careful that relay arm does not rub on side of relay frame or against stop wheel and that spring does not shift closer to contacts when tightening these screws.

(7) Check operation of motor contacts. With power off, depress clapper of relay and turn gearing to let pawl tip rest on stop wheel between notches. In this position motor-operating contacts should be closed and the clapper and arm should have a small amount of free play to permit full contact pressure at the contact points.

If necessary bend the stationary contact in or out. Failure to make contact in this position may allow the autopositioner to "set up" at the wrong position, with the seeking switch circuit open but with the pawl between notches; excessive free play of the clapper in this position indicates insufficient contact opening in the de-energized position.

(g) Causes of Failure:

(1) Relay spring bent up so that pawl is not seated in notch and may kick out on some or all channels, causing continuous operation.

(2) Relay shifted out of alignment.

a. Away from pawl, so that pawl does not lift clear of notch, leaving relay energized.

b. Towards pawl, so that pawl cannot seat fully in notch and may kick out.

(3) Motor contacts on relay bent together so that motor does not shut off, or bent apart so that motor does not operate, leaving relay energized. Or contacts may be spread apart just far enough so that the motor stops before pawl drops into notch, allowing autopositioner to "set up" between proper positions.

(4) Relay air gap altered, changing travel of pawl.

a. Excessive gap, weakening relay so that it may fail to disengage pawl from notch, leaving relay energized. (This may be done inadvertently when the relay has been shifted - see 2a.)

b. Insufficient gap, so that pawl does not lift clear of notch. (This may be combined with shifting of the relay as in 2b., so that pawl lifts clear but does not seat fully.)

(5) Switches out of synchronization.

a. In receiver -

1. Slight misalignment may cause pawl to drop too late, catching on far edge of notch, so that it does not seat fully and does not shut off motor.

2. Further misalignment may cause pawl to miss notch on some positions but set up all right on others.

3 Extreme misalignment may prevent proper operation on all channels.

4 If initial switch synchronization is made near one end of the slotted holes, it may be possible to misalign the switches so that the autopositioner sets up on the wrong position, one notch too high or too low in frequency.

b. In remote control - may fail to make contact on all wires - see item 11.

(6) Tight bearings due to insufficient burnishing or to misalignment of of bearings, either on autopositioner or on driven slug racks, may cause autopositioner to stick momentarily or permanently, especially at low temperature, producing a longer cycling time or continuous operation of relay and motor.

(7) Binding of pawl on its pivot due to insufficient radial or end play may prevent relay from disengaging pawl, or more probably will prevent or delay pawl from dropping into notch, causing continuous operation.

(8) Lack of lubrication, dirt on lubricated surfaces, or use of non-low-temperature oil and grease may cause failure at low temperature, especially in combination with other factors, such as bearing tightness.

(9) Corrosion on pawl and stop wheel may cause pawl to stick in notch. The use of type 302 stainless on the 51R-2 and all other future autopositioners will minimize this danger.

(10) Insufficient clutch torque due to broken clutch springs may cause temporary or permanent sticking of the autopositioner shaft, especially in combination with other factors. Age, temperature, or even oil or grease on the clutch face have little effect on its torque. However, accumulated dirt, grit or varnish will. Continous running may also glaze or abrade the clutch surfaces.

(11) A broken control wire, or loose connection on one wire will allow the autopositioner to set up on either one of two positions which satisfy the conditions of the remaining control wires.

(12) A control wire shorted to ground will let the autopositioner set up properly on any channel for which the corresponding wire is supposed to be at ground potential, but will cause continuous operation on all other channels.

(13) A short between two control wires will allow proper operation on any channel for which the two wires are supposed to be at the same potential but will cause continuous operation on all other channels.

(h) Trouble Shooting Guide:

Possible failures with probable causes:

(1) Motor continues to run after Autopositioner sets up.

a. Contacts bent; see (f)(7)

b. Spring weak, pawl does not seat fully; replace relay, replace spring, or remove and bend spring to increase tension.

c. Seeking switch out of synchronization, causing pawl to drop late and catch on far side of notch and not seat fully; adjust switch stack.

d. Intermittent or continuous short to ground on negative side of motor.

(2) Autopositioner sets up on wrong channel part of time.

a. Broken wire or poor connection on one or more control wires. Note which channels give ambiguous results; from Figure 2-23 in the 51R-2 instruction book, note which wire is designed to differentiate between these ambiguous channels; this wire is probably open.

b. Open circuit between ground and front side of remote switch. Note whether autopositioner sets up on wrong channel for which the code given in Figure 2-23 of instruction book is exactly opposite to code for proper channel. This indicates no ground on remote switch. Check by grounding front blade (by means of long clip) on remote switch when autopositioner sets up improperly.

c. On 1/10-mc Autopositioner, the fault may be in relay K-103 if the autopositioner sets up one megacycle too high or low; check wire J, relay contacts, and wiring to switch S-104. Relay K-103 should be energized on all odd megacycles, open on even megacycles.

(3) Autopositioner sets up on some channels, runs continuously on others.

a. Control wire shorted to ground. From code on Figure 2-23 in 51R-2 instruction book, note whether one wire is supposed to be grounded on the O.K. channels, ungrounded on the others; this wire may be shorted to ground.

b. Control wires shorted to each other. From code determine whether two (or more) wires are supposed to have same connections (both grounded or both ungrounded) on all O.K. channels, opposite connections on all other channels. These wires may be shorted.

c. Switch out of synchronization, allowing pawl to drop too early or too late on some channels. Check visually when set up.

(4) Autopositioner does not set up on any channel, stop wheel turns freely, relay opens momentarily each revolution of shaft.

a. Spring bent, pawl does not engage stop wheel with sufficient force to hold.

b. Switch out of synchronization.

c. Pawl sticks on its pivot.

d. Relay shifted, does not allow pawl to seat properly.

e. Pawl tip shape altered severely, does not hold.

(5) Autopositioner does not set up on any channel, stop wheel turns freely, relay remains energized continuously.

a. Wire from relay to seeking switch grounded.

b. Rear switch blade grounded by short between rear and front blades.

c. Several of all control wires shorted to ground.

d. Rear blade of remote switch grounded, possibly by short between rear and front blades.

e. On 1/10-mc autopositioner fault may be in contacts on relay K-103 or on switch S-104 if both wires from the relay to the switch are grounded or if the rear blade of S-104 is grounded permanently.

(6) Autopositioner does not set up, stop wheel does not turn freely, relay energized, motor running.

a. Pawl does not lift clear of notch.

1 Relay shifted away from pawl.

2 Relay has insufficient travel; see section(f) on adjustment.

b. Slug table jammed by physical obstruction.

c. Gears (on 1/10 mc Autopositioner) jammed (i.e., solder in gears).

d. Autopositioner or slug table bearings out of alignment, binding shaft.

e. Pawl sticks on its pivot.

f. Improper lubrication on bearings (at low temperature).

g. Insufficient clutch torque.

1 Broken clutch springs.

2 Glazing of clutch surfaces.

(7) Autopositioner sets up, then recycles by itself.

a. Spring bent, does not hold pawl in notch properly.

b. Relay shifted, pawl does not seat fully.

c. Pawl tip altered, excessive slope or radius causes pawl to be pushed out of slot.

d. Intermittent short circuit between control wires or from wires or switch to ground.

e. Switch out of synchronization, operation marginal.

f. Broken control wire or intermittent open circuit may allow autopositioner to set up on wrong channel, then close circuit momentarily to drive autopositioner on to proper channel.

(8) Autopositioner relay closes, motor does not run.

a. Relay contacts bent, not closing motor circuit.

b. Open circuit from relay to motor.

c. Moving contact not grounded properly to frame, or frame to panel.

d. Contacts dirty.

e. Moving contact bent (or temper lost as result of short circuit), not sufficient contact pressure.

f. No power on positive side of motor.

g. Motor armature burned out.

h. Motor field (permanent magnet) de-magnetized.

i. Reduction gears jammed; check by turning manually.

(9) Autopositioner relay does not operate.

a. No power on positive side of relay.

b. Open circuit from relay to seeking switch.

c. Control wire circuit open.

d. Relay coil burned out.

e. No air gap on relay.

5.2. POWER SUPPLY MAINTENANCE.

5.2.1. DYNAMOTOR. - Dynamotors should be given the same routine inspection accorded other components of the radio or other associated equipment. After every 500 hours of operation, or approximately every 6 months, inspect for loose connections, loose brush holder caps, dust on brush holders and capacitor surfaces, excessively worn or grooved commutators and worn brushes. The condition of the brush faces should be such as to indicate proper seating on the commutator. A minimum brush length of 1/4" is necessary for successful operation. To remove brushes unscrew the bakelite brush holder caps and pull out the brush assemblies. Cartridge type brush holders are used. The brush, shunt cable, spring and end plug are on an assembly and will, therefore, come out as one piece. To facilitate replacement, each brush is stamped plus or minus, and similar markings are located adjacent to the brush holders. Brushes should always be inserted in the brush holders with polarity marks upward. Following this method consistently insures correct replacement at all times. Broken or cracked brushes should be replaced.

After every 500 hours of operation inspect the commutators for evidence of pitting, burning, or grooving. An even, dark brown, polished brush track, which is not pitted or grooved, indicates good commutation. Grease and oil must not be allowed to accumulate on the commutators and brushes. If any lubricant is present, remove it by wiping with a cloth saturated with gasoline.

(a) Bearings. - Grease-sealed ball bearings are used. They are lubricated for approximately 1000 hours of operation or 6 months to one year of ordinary service before dynamotors leave the factory. Regreasing should only be done if absolutely necessary and at the time the dynamotor is removed for periodic maintenance.

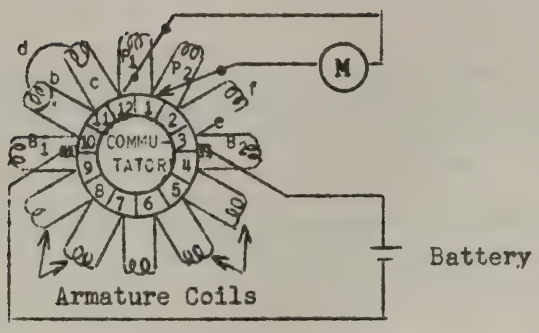
(b) Brushes. - Replacement brushes will be furnished with a radius formed on their faces to fit the commutators, thereby eliminating "sanding-in". Before installing new brushes, examine the shunt cable and, if necessary, shape the cable in such a manner that it is possible to the direction of brush travel, so that it will not work out between the turns of the spring and interfere with normal spring action. Try the brushes in their holders and if they do not slide back and forth freely when manipulated by hand, examine the brush holders for obstructions and, if necessary, sand-paper the edges of the brushes for free fits. After the brushes are inserted replace the brush holder caps. After installing new brushes, it is advisable to run them in at partial load until a dark brown commutator film has been established. Noisy and inefficient operation may be experienced until the brushes are properly seated.

(c) Commutator. - Slight grooving of the commutators is not unusual after several hundred hours of operation and may be considered normal. If, however, it is desired to repolish the commutators, they may be polished with crocus cloth. Slight pitting can be removed by the use of commutator dressing sticks of pumice grade by holding the end of the stick against the commutator face, exerting very light pressure, while the dynamotor is running. This should be followed by canvas or crocus cloth polishing. Do not use emery cloth on commutators. Standard rotation of Continental dynamotor armatures is counter-clockwise when facing the low voltage end. Dressing should therefore, be done by holding the commutator stick with the right hand from the right hand side of the dynamotor. If commutators, through improper operation become seriously worn or scored, it will be necessary to refinish them. This can be done only at a properly equipped repair station.

To lubricate the ball bearings remove the bearing cover plates in the end castings. They are held in place by flat head screws in each casting. If inspection indicates the need for additional lubricant, use Andok C grease (Standard Oil Company of N.J.), adding only a sufficient amount to cover the balls and ball retainers. Do not pack the bearings with grease as it may work out of the bearings into the dynamotor adjacent to the brush holders where it will tend to retain carbon dust, etc. and may also cause abnormal heating of the bearings.

(d) Dynamotor Trouble Shooting. - If a dynamotor that has been operating normally, suddenly develops trouble of a nature that causes brush sparking, or if the output voltage drops appreciably and the input current increases above normal, or if unusual audio noise develops in the radio equipment, it is likely that a fault has developed in the armature. It is, however, advisable to check the brushes to make sure they are properly contacting the commutators. If the brushes appear to be satisfactory the dynamotor should be removed from the radio equipment for bench tests. The instructions that follow will aid in locating faults. All the tests can be performed by the use of an analyzer of the Volt-Ohm Milliammeter type commonly used for servicing radio equipment. The accompanying sketch shows methods of making tests on armatures. This test set-up uses a minimum of equipment and is applicable to any 2 pole d-c armature. In the case of this dynamotor armature, it is intended primarily as reference for checking low voltage windings of low resistance. Tests for faults in the high voltage windings are best made in the ohm-meter position of the analyzer. The Ohmmeter method cannot be used satisfactorily for low voltage dynamotor armature windings because of their extremely low resistance. "M" in the sketch represents the lowest d-c voltage scale available on the analyzer, or one of the milliampere scales. The battery should be a two volt cell of a storage battery.

For testing a low voltage armature winding, disconnect the field coils from the armature by removing the shunt field connections from the low voltage brush holders. Connect the battery to the brush holder



Armature Test Circuit

terminals B1 and B2 using short leads. The voltage available at the brush holders will be approximately 1.8 to 2.0 volts with the battery in good condition. If the armature tends to rotate, hold it by hand or block it with a small wedge.

Testing of the low voltage winding of the armature is accomplished by successively contacting all adjacent commutator bars with the test prods P1 and P2. If there are no defects in the winding, the voltmeter will read approximately uniform for all the bars because the voltage drop is about the same for all the coils. Slight variation may be expected but differences on the order of 25% are too high and indicates a partly shorted coil. The resistance of some armature windings, particularly those in dynamotors of low input voltage or high input current rating, may be so low that the needle movement when using the voltmeter method is too small for determining differences between bars. In such case the analyzer may be used in the milliammeter position, selecting a scale of sufficient sensitivity to show readings in which differences can be detected. The milliammeter method should not be resorted to until it has first been determined by the voltmeter method that there are no "opens" in the armature winding. Otherwise full test voltage will be impressed on the milliammeter when the test prods contact the two bars between which an "open" exists and possibly burning out the meter. If two bars are shorted as at "a" or if two leads are shorted as at "b" the voltmeter will not show any reading. A short circuit between parts of the turns of one coil as at "c" will show a low reading. A short circuit between parts of turns of one coil as at "d" will also show a low reading. A loose or poorly soldered commutator connection causes high resistance and will be indicated by an abnormally high reading. "Open" circuits in a coil as at "e" or "f" prevents flow of current through that part of the armature. When the test prods are touched to any two bars in the "open" half of the armature the meter will not show any deflection until the bars between which the "open" exists are touched. Full battery voltage of about 2 volts will then be applied to the analyzer scale.

Testing of the high voltage winding is accomplished by reading the resistance between each pair of bars in the high voltage commutator, using a suitable ohmmeter scale of the analyzer. The resistance value between adjacent bars should be uniform all around the commutator. A complete "short" between adjacent bars will show zero resistance. A partial "short" will be indicated by an irregular value from zero to the normal resistance of a good winding. When partial "shorts" are encountered, they often show up in three or four adjacent bars, indicating break-down in several sections of the same coil, or between coils.

"Shorts" between different coils in the high voltage winding as at "d" cannot always be found by reading the resistance between bars but can be identified by connecting the ohmmeter to the brushes and slowly rotating the armature by hand. A resistance reading of progressive variation when the armature is rotated by hand indicates a fault of this type. An "open" in any coil will be indicated by a total resistance many times higher than the resistance of a good coil when measured between the adjacent bars where the "open" exists. Two or more "opens", if in opposite halves of the winding, will show infinite resistance.

"Grounds" in the low voltage winding can be located by impressing two volts between the brush terminals with the field coils and connecting leads disconnected from the brush holder terminals. Use a low voltage d-c scale of the analyzer, connecting one test prod to the frame and touching the other prod successively to each commutator bar. The deflection will be least when the bar to which the grounded coil is connected is touched. The same method should be followed for the high voltage winding, except a 24 volt battery and a suitable d-c voltage scale of the analyzer should be used. This method of ground location is only practical for direct grounds. High resistance grounds or punctured insulation can only be located by the use of equipment capable of supplying potentials of at least 500 volts a.c. or d.c. "Grounds" in the windings are usually caused by insulation break-down within the armature. There is, however, a possibility of the "ground" being caused by a stray metal chip between commutator bars and the commutator core. Such a fault can readily be corrected by removing the cause. Internal grounds are not possible of correction without rewinding the armature, and it is therefore, necessary that complete armature replacement be made.

"Dead shorts" in the armature windings may be located at the commutator bars or in the leads connecting to them, and are often possible to correct. The cause may be a metal chip between adjacent bars or may be due to improper mica undercutting between two bars, resulting in the bars touching each other. Internal or partial "shorts" are beyond the probability of field repair and will necessitate armature replacement. "Opens", if at the commutator bars, can often be corrected by the application of heat from a small soldering iron to the riser of the bars where the "open" is indicated. If the "open" is inside the coil and not accessible, the two bars between which the open is located can be joined together by a small jumper. In operation the output voltage will drop slightly, but satisfactory operation will be possible for emergency use.

"Opens" or "shorts" may develop in the field coils. Although a dynamotor may start with an "open" field the starting current will be much higher than normal and the acceleration and running speed will

be much higher than normal. A "shorted" field may prevent starting entirely and may blow the protective fuses in the input circuit if used. "Open" or "shorted" fields can readily be determined by ohm-meter measurements.

Experience has shown the following listed reasons for unsatisfactory dynamotor performance to be the most common in service. Corrective steps are in most cases obvious after the cause has been located.

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Failure to start.	(a) No voltage or improper input voltage; "open" in input circuit wiring or power cable; blown input fuse, if used; defective starting switch or relay.	Check battery voltage or replace battery if necessary. Check and repair "open" or loose connections in input circuit; replace blown fuse; repair switch or relay.
	(b) Armature winding may be "open".	Repair at repair station or make armature replacement.
	(c) Worn low voltage brushes.	Replace brushes.
	(d) Dirty low voltage commutator.	May be due to grease on commutator. Clean with cloth saturated with gasoline or dress the commutator.
2. Excessive speed.	(a) Shunt field may have short-circuited turns or an "open"	Repair at repair station or replace defective coil.
3. No output or low output.	(a) Poor commutation resulting from dirty commutators, worn brushes or weak brush springs.	Clean commutators with cloth saturated with gasoline, or dress the commutator.
	(b) Low input voltage.	Check input circuit for loose connections; tighten if necessary. Check battery voltage and recharge or replace if necessary.

SYMPTOM	PROBABLE CAUSE	REMEDY
4. Excessive output.	(a) Input voltage too high.	Substitute battery of correct voltage.
	(b) If battery charger is normally used while operating dynamotor, battery connections may have been disconnected and dynamotor is operating from charger.	Reconnect battery.
5. Flashing at commutators	(a) Dirty Commutators; worn brushes.	Clean commutators with cloth saturated with gasoline, or dress the commutators. Inspect brushes and replace with new brushes if necessary.
6. Excessive electrical noise in radio equipment.	(a) High audio frequency ripple due to dirty commutators or worn brushes, or due to defective armature.	Clean commutators with cloth saturated with gasoline, or dress the commutators. Inspect brushes and replace with new brushes if necessary.

5.3. INSTRUMENT MAINTENANCE.

5.3.1. 332C-1 RADIO MAGNETIC INDICATOR. - The Type 332C-1 RMI is manufactured by the Kearfoot Engineering Co. and is hermetically sealed. If this instrument requires adjustment or repair, return it to the Kearfot Engineering Co., 117 Liberty St., New York 6, New York.

5.3.2. DEVIATION INDICATOR. - The 51R Receiver uses the Weston Electrical Instrument Corporation Type 888, Type 3 Blind Approach Indicator. (USAF Type ID-48AF/ARN). The following procedure for the maintenance of this instrument is recommended by the Weston Corporation:

(a) Installation Inspection. - Inspect installation periodically to make certain that the electrical connections are clean and tight and that the insulation on the cables is not frayed or broken. If either the glide slope or localizer pointer does not lie along the corresponding row of dots, the pointer should be reset to the correct position by use of the zero correcting screw on the front of the instrument. Depress the beacon lamp housing to test the operation of the lamp. Lamps which do not light under this test should be replaced.

(b) Service Test. - The indicator should be periodically removed from the cockpit panel and connected in the calibrating circuit shown in the accompanying illustration. Apply the current indicated below:

Mechanism	Range Microamperes
Localizer	150-0-150
Glide Path	150-0-150
Vertical Flag	125-250
Horizontal Flag	125-250
Beacon Lamp	24 volts

The instrument should next be tested for friction by slowly increasing the current from zero to full scale value. The pointer motion should be smooth and any tendency on the part of the pointer to hesitate or stick at a particular place on the scale should be investigated because of the possibility of a foreign particle becoming lodged in the inner gap causing interference with the normal movement of the moving coil. If the instrument adjustment is not within the tolerances stated on the type sheet it will be necessary to readjust the indicator as described under Electrical Adjustment.

(c) Overhaul Tools Required. - The following list of special tools is required to repair the Model 888 Blind Approach Indicator. The tools can be purchased from the Ideal Laboratory and Tool Supply Company, Cheyenne, Wyoming.

Weston Part Number	Nomenclature	Application
ST2669	Wrench, Socket, .190" Hex.	Moving Movement Bracket
ST18494	Wrench, Socket Insert	Removing Spring Nut
ST19513	Handle, Socket Wrench	Holding ST18494
ST19645	Inserter, Pivot	Inserting Pivot
ST19646	Handle, Pivot Inserter	Holding ST19645
ST54533	Pliers, Pivot Extracting	Removing Pivot
ST55559	Wrench, Spring Balance	Adjusting Balance Weight
ST56007	Wrench, Hex. Balance	Adjusting Tail Weight

(d) Pre-Repair Inspection. - Before proceeding with any extensive repairs, it is well to verify defect reports since much time and labor may be saved by correcting superficial defects. Always check the calibration as explained under Electrical Adjustments before removing the instrument case. Rock the instrument from side to side as the current is increased to full scale value and reduce gain to zero to test for hesitation or sticking of the pointers. Friction may be caused by magnetic particles in the air gap, fuzz on the movable coil, core,

scale plate, or pointer or by damaged pivots or jewels. If the mechanism shows friction or is open circuited, proceed with the disassembly, re-assembly, and adjustment as indicated below. Disassemble the instrument only far enough to reach the indicated fault.

(e) Repair. - If it is found necessary to repair one or more of the moving elements for any reason such as damaged moving coil, broken pointer, damaged springs or worn pivot, the procedure outlined below should be followed. Because of the delicate nature of the parts, repairs should be made by trained instrument mechanics with proper tool facilities.

(1) Disassembly.

a. Remove the four screws that hold the three pin receptacles to the rear shield. Withdraw the receptacle as far as possible and unsolder the three leads that connect the receptacle to the lamp assembly. All wiring in this instrument is color coded for easy identification.

b. Remove the four screws that hold the case to the base and carefully lift the case from the instrument proper. The three leads previously unsoldered from the three pin receptacles should be withdrawn from the case. Care should be exercised to prevent the leads from damaging the moving elements and the springs of the adjacent mechanism.

c. Unsolder the leads of the mechanism to be repaired and remove the screws that hold this mechanism to the support plate. This operation must be done very carefully to avoid having the magnet attracted to the steel scale plate or to the adjacent magnets with the possibility of damage to the pointers or moving elements. A single mechanism or all four mechanisms may be removed in like manner.

d. Remove the two screws that hold the Bakelite deck to the magnet. Place the mechanism on a soft iron plate which will act as a keeper for the magnet, diverting the magnetic flux from the air gap and will support the mechanism firmly for further repair operations.

e. Remove the two screws that hold the movement bracket to the magnetic sector and carefully slide the mechanism back and upward out of the position between the magnet pole pieces.

f. Unsolder the top and bottom moving element springs from the respective abutments and back out the top jewel screws turning counter-clockwise until the moving element falls free of the jewel. Carefully lift the moving element out of the bracket assembly.

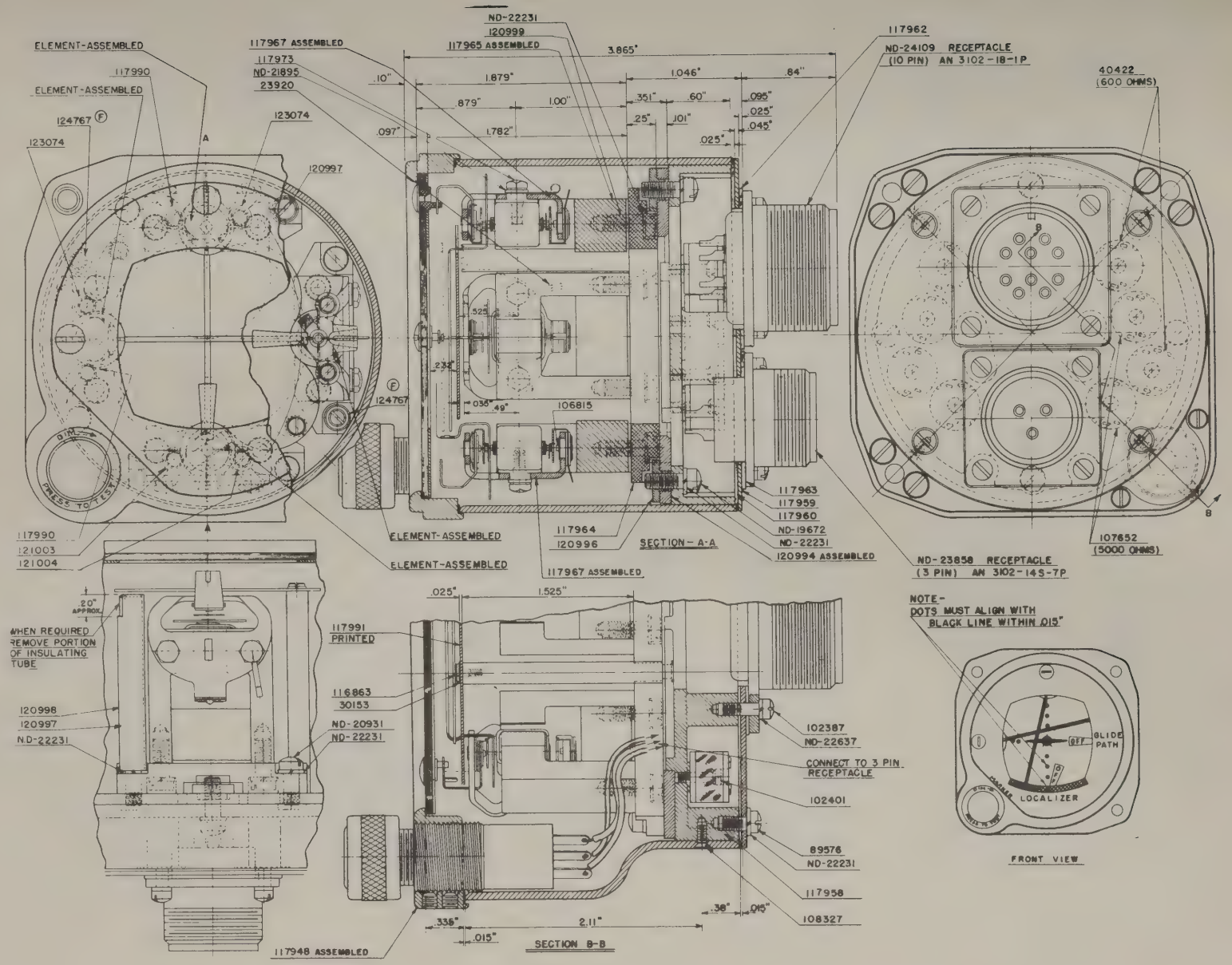


Figure 5-3 Deviation Indicator Details

g. Remove the small nuts that hold the pointer and springs of the moving coil. Lift the springs off by grasping the spring terminal with tweezers. Remove the pointer.

h. Hold the moving coil between the thumb and index finger and grip the shank of the pivot in a pivot extractor, ST54533, or in the chuck of a jeweler's lathe. Turn the moving coil and the pivot in opposite directions while exerting a steady pull. Care should be exercised not to exert too much pressure on the extractor or a broken or damaged coil may result.

(2) Re-Assembly.

(a) Place the moving coil on a moving element assembly fixture as shown in the sketch and using the Pivot Punch, ST19645, and Handle, ST19646, force new pivots into the pivot base. The Pivot Punch is designed to insert the pivots to the proper depth when the end of the punch is in contact with the pivot base.

(b) Remount the springs and pointers and tighten the pivot base nuts in place. Correct position of the pointer spring termination is shown in the sketch designated as "Spring Termination".

(c) Remove the jewel screws from the movement bracket and clean the jewels by sharpening a wooden match stick to a three-cornered point and twisting it a few times in the pit of the jewel. Do not wash the jewels in any form of cleaning fluid. Examine the pit of the jewel for fractures of the surface by probing lightly with a sharp sewing needle, Size #10. Replace jewels where rough surface indicates a fracture.

(d) Place the moving element in the proper position in the bracket assembly and carefully turn the bottom jewel screw in a clockwise direction until the bottom pivot engages the cup of the jewel and the moving coil is lifted clear of the top of the coil. Grasp the pointer lightly and drive the top pivot into the cup of the top jewel while slowly tightening the top jewel screw. Equalize the clearance between the inside top and bottom of the moving coil and the core by alternately adjusting the top and bottom jewel screws.

(e) By blowing lightly on the pointers, adjust the jewel clearance by gradually turning the top jewel screws clockwise until a slight binding of the moving element is apparent. Note the position of the slot in the top jewel screw and turn the jewel counter clockwise one third of a revolution. Particular attention should be given to the

shape of the screw driver blade which should be hollow ground to an inch thickness of .009 inch to prevent its being necessary to apply excessive pressure to keep the blade in the jewel screw slot. Do not press too heavily on the screw driver during this adjustment for excess pressure will deflect the blade and result in incorrect jewel clearance or possible damage to pivots or jewels.

(f) Resolder the moving element springs to the respective bridge terminals. Remount the moving bracket in the magnet assembly.

(g) Remove the assembled mechanism from the soft iron plate. Remount the Bakelite deck and assemble the completed mechanism on the support plate. NOTE: In the event that it is found necessary to recharge the magnet, it is essential that all four magnets be charged so that the poles adjacent to the mechanism are of the same polarity. Refer to the drawing that illustrates the polarity of the magnets as the instruments are manufactured. This polarity and the direction of winding of the moving coils is important to the proper deflection of the pointers. Standard practice in regard to the direction of winding the moving coil is to maintain the starter joint on the top pivot space of the right, as viewed from the tail of the pointer. The one exception to this is the vertical flag moving coil on which the starter joint is positioned on the operator's left to provide proper deflection.

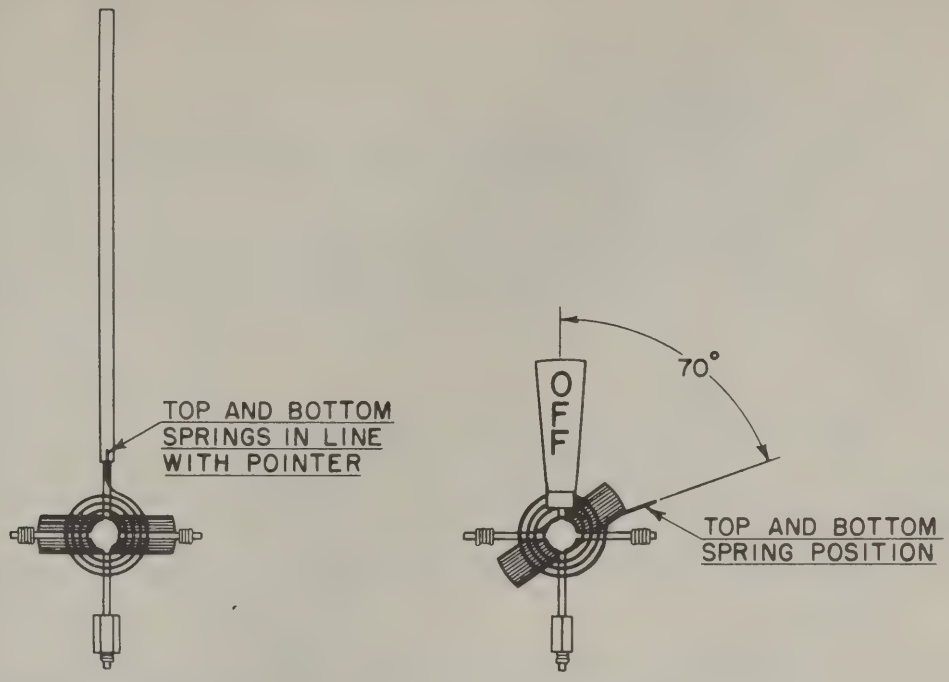
(3) Balance Adjustment. - The following operation should be performed on each mechanism:

(a) Set the instrument on the bench with the scale face upward and set the pointers in the normal zero position by shifting the zero corrector abutment to align the pointers with the corresponding row of dots on the scale. The pointers should be centered over the dots farthest from the pivoted end of the pointer.

(b) Pick up the instrument so that the scale plate is in the vertical plane and rotate it until the corresponding row of dots is in horizontal plane. Note position of the pointer and readjust the tail balance weight until the pointer is again aligned with the row of dots. Tap the instrument while performing the operation.

(c) With the scale plate vertical, as before, rotate the instrument until the corresponding row of dots is vertical. Note the position of the pointer and readjust the slide arm valve weight until the pointer is correctly aligned with the dots. Tap the instrument while performing this operation.

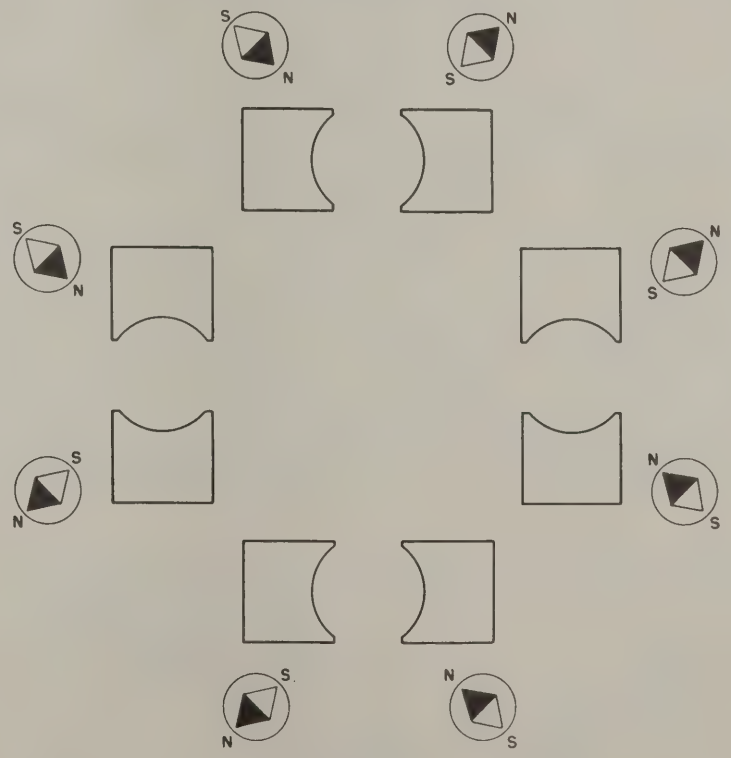
(d) Repeat operations 2 and 3. It will probably be found that several adjustments are necessary before the mechanism is properly balanced. The main pointers are within balance limits when the



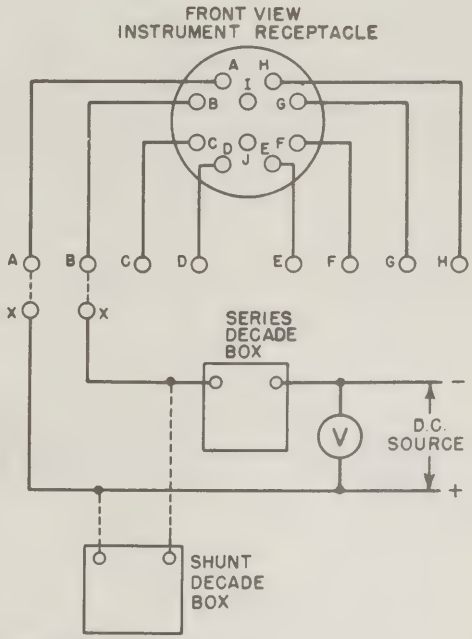
(A) LOCALIZER AND GLIDE PATH ELEMENTS

(B) FLAG ELEMENTS

SPRING TERMINATION



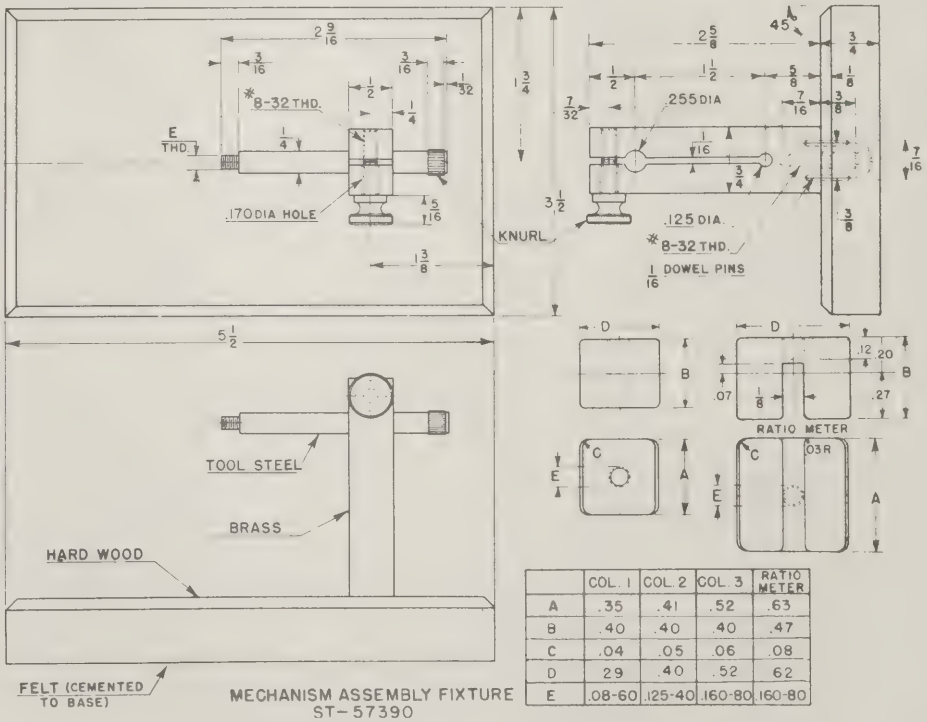
MAGNET POLARITY



CONNECT LEADS X-X TO EACH PAIR OF LEADS IN TURN.

MECHANISM	RECEPTACLE PINS		DEFLECTION
	+	-	
LOCALIZER	A	B	RIGHT
GLIDE PATH	C	D	DOWN
VERTICAL FLAG	E	F	RIGHT
HORIZ. FLAG	G	H	UP

CIRCUIT FOR ADJUSTMENT AND CALIBRATION



	COL. 1	COL. 2	COL. 3	RATIO METER
A	.35	.41	.52	.63
B	.40	.40	.40	.47
C	.04	.05	.06	.08
D	29	.40	.52	62
E	.08-60	.125-40	.160-80	.160-80

MECHANISM ASSEMBLY FIXTURE
ST-57390

MOVING ELEMENT ASSEMBLY FIXTURE

pointers check as in operation 1. A portion of the pointer is within the circumference of the dot in operations 2 and 3.

(3) In making balance adjustment of the flag mechanism, it will be necessary to apply sufficient current to the mechanism to deflect the pointer away from the lower end pointer stop. Balance operations should then proceed as described above.

(4) Electrical Adjustment.

(a) Mount the case on the instrument temporarily with the two case screws and set the indicator pointers on the normal zero position by means of the zero correcting screws on the front of the glass.

(b) Remove the four screws that hold the ten pin AN receptacle on the rear shield and remove the four screws that fasten the rear shield to the base.

(c) The vertical row of dots on the scale should be aligned with the marks between two sectors printed on the mask within .015 inches. If the vertical row of dots is not in line with the marks it will be necessary to partially loosen the four adjusting screws located symmetrically around the inner perimeter of the base. The entire mechanism support plates can then be shifted until proper alignment occurs. The adjustment screws should then be tightened.

(d) If a single mechanism has been repaired it will only be necessary to unsolder the shunt spool connected to this mechanism and to connect a short circuiting wire across the series spool of this mechanism in order that the electrical adjustment may be facilitated.

(e) Connect the mechanism in the calibrating circuit and apply the end scale current as indicated. The indicator should rest above the end scale dot and it will be necessary to shunt the dial box to the correct value to provide proper end scale deflection. Currents of less than one milliampere are most conveniently obtained by applying a voltage through a high resistance. A convenient voltage such as 15 volts is selected and the value of the series resistance is determined by Ohms law. The instrument resistance must be subtracted from the calculated resistance. In cases where the moving element will be adjusted by shunting the nominal, approximate resistance of the shunted moving element is subtracted from the calculated value.

(f) The resistance of the moving element should be measured on a Wheatstone bridge and the resistance of the shunted moving element calculated from the equation:

$$\text{R of shunted moving coil} = \frac{R_{me} \times R_{shunt}}{R_{me} + R_{shunt}}$$

The series resistance is then calculated by subtracting the shunted moving element resistance from the total resistance as given on the type sheet. For example, assuming a moving element resistance of 638 ohms, a shunt resistance of 750 ohms, and a desired total resistance of 1000 ohms, then $R_{me} = \frac{638 \times 750}{638 + 750} = 410$ ohms.

$R_{series} = R_t - R_{me} = 1000 - 410 = 590$ ohms. The shunted series resistance spools should then be adjusted to the necessary values and the spools mounted in position and connected in the circuit. The desired shunt resistor can be adjusted to the proper value, connected in place, and a dial box connected in series. The combination is next connected to a Wheatstone Bridge to measure the desired total resistance when balanced. The dial box is then adjusted so that a balance is obtained and the necessary series resistance read directly from the dial box.

(g) Adjustment of the flag mechanisms will require alternate adjustments of the shunt dial box and the top spring abutment to achieve the proper deflection. The flag mechanism is adjusted so that with the low-end current applied, the flag pointer partially covers the row of dots and with the high-end current applied, the flag pointer is out of sight under the edge of the mask. Proceed as outlined below:

a. Connect the flag mechanism (shunt and series resistors cut out of the circuit as in (d) above) in the calibrating circuit and note the current required to deflect the flag to the normal off current position over the dots on the scale. Apply and note the current required to bring the flag just out of sight under the mask. The difference between the high-end current and the low-end current should be less than 250 minus 125 microamperes or 125 microamperes. If the difference is greater than 125 microamperes, it will be necessary to recharge the magnet.

b. Apply 125 microamperes and adjust to the low end position (over the scale dots) by moving the top spring abutment.

c. Apply 250 microamperes and adjust the shunt dial box until the flag is just covered by the mask.

d. Apply 125 microamperes and readjust the abutment to correct the low end indication.

e. Apply 250 microamperes and again shunt until the flag is just covered.

f. Alternately apply 125 microamperes and adjust the abutment and 250 microamperes and shunt until the adjustment is within the

limits of 125 ±6 microamperes at the low-end and about 250 ±12.5 microamperes at the high-end position.

g. Adjust the low-end pointer stop to maintain the off-current position of the flag over the associated main pointer.

h. Adjust the shunt and series resistors to the necessary resistance and mount the resistors in place.

(h) Adjust the main pointer stops to permit the pointers to deflect slightly past the end dots but short of interferring with the motion of the other main pointers at the point of greatest deflection.

(i) Remount the rear plate and 10-pin receptacle taking care that the leads to the spools are not compressed between the base supports and the plate and that the soldered joints on the spools do not touch the rear plate gasket. Compression of the leads, or soldered joints penetrating the gasket will eventually ground the circuit interferring with the proper operation of the system.

(j) Remove the case and inspect the internal parts, removing particles from the air gap, fuzz from scale and pointers, etc. Remount the case and reconnect and mount the 3-pin receptacle. The instrument is then ready for a final electrical check and service.

(5) Parts List.

MODEL 888 BLIND APPROACH INDICATOR

DESCRIPTION	WESTON PART NO.	QUANTITY PER UNIT
Case - Assembled	122449	1
Case	117949	1
Front	117951	1
Gasket	117952	1
Screw (#4-48) (Case to Front)	100120	6
Screw (#2-64) (Case to Front)	108328	2
Glass	117953	1
Mask-Printed	121640	1
Clip (Glass to Front)	117957	4
Screw (Clip to Front)	89595	4
Stud (Zero Corrector)	114027	2
Crank (Zero Corrector)	71356	2
Washer (Zero Corrector)	93101	2
Lamp & Switch Assembly	ND23860	1
Screw - Hexagon Socket Set (#6-32 x 1/8")	ND23864	2
Base	117958	1
Screw (Case to Base)	108327	4
Shield	122450	1
Gasket (Shield to Base)	117960	1
Receptacle - 10 Pin (AN3102-18-1P)	ND24109	1
Gasket - 10 Pin Receptacle	117962	1
Receptacle - 3 Pin (AN3102-14S-7P)	ND23858	1
Gasket - 3 Pin Receptacle	117963	1
Screw (Mounting Receptacles)	102387	8
Washer - Lock (Mounting Receptacles)	ND22637	8
Screw (Shield to Base)	89576	4
Washer - Lock (Shield to Base)	ND22231	4
Plate - Assembled, Movement	120994	1
Nut (Plate to Base)	120995	4
Screw - #6-32 x 3/8" (Plate to Base)	ND19672	4
Washer - Lock (Plate to Base)	ND22231	4
Base - Movement	117964	4
Screw - #6-32 x 5/16" (Base to Plate)	ND20931	4
Stud - Case Guide	120997	2
Tube - Insulating	120998	4
Washer - Lock Move. Base to Plate	ND22231	8
Stud - Case Guide and Stop	124767	2
Magnet - Assembled	117965	4
Screw (Magnet to Move. Base)	120999	8
Washer - Lock (Magnet to Move. Base)	ND22231	8
Bracket - Assembled, Movement	117967	4
Stud - Bracket to Magnet	117973	8

DESCRIPTION		WESTON PART NO.	QUANTITY PER UNIT
Washer - Lock (Bracket to Magnet)		ND21895	8
Terminal		23920	4
Element - Assem., Moving Localizer (Type 3Y-2)		117974	1
Element - Assem., Moving Localizer (Type 3Z-2)		123727	1
Pointer Assembled Type 3Y-2		117975	1
Pointer Assembled Type 3Z-2		123729	1
Frame - Wound		121529	1
Springs - Paired 34 Total Test		110824	1 pr.
Pivot		88239	2
Nut		22960	2
Weight - Spiral Balance 4 Turns		107381	
Weight - Spiral Balance 6 Turns	Side Arms	107382	
Weight - Spiral Balance 8 Turns	As required	106356	2
Weight - Spiral Balance 12 Turns		81041	1
Nut	Tail	108529	1
Nut	As required	122590	1
Element - Assem., Moving, Glide Path (Type 3Y-2)		117978	1
Element - Assem., Moving, Glide Path (Type 3Z-2)		123726	1
Pointer Assembled Type 3Y-2		117979	1
Pointer Assembled Type 3Z-2		123728	1
Frame Wound		121529	1
Springs - Paired 34 Total Test		110824	1 pr.
Pivot		88239	2
Nut		22960	2
Weight - Spiral Balance 4 Turns		107381	
Weight - Spiral Balance 6 Turns	Side Arms	107382	
Weight - Spiral Balance 8 Turns	As Required	106356	2
Weight - Spiral Balance 12 Turns		81041	
Nut	Tail	122590	
Nut	As Required	86808	1
Element - Assembled, Moving, Localizer Flag Alarm		117981	1
Pointer Assembled		117982	1
Frame - Wound		117985	1
Springs - Paired 30 Total Test		107071	1 pr.
Pivot		88239	2
Nut		22960	2
Weight - Spiral Balance 4 Turns		107381	
Weight - Spiral Balance 6 Turns	Side Arms	107382	
Weight - Spiral Balance 8 Turns	As required	106356	2
Weight - Spiral Balance 12 Turns		81041	
Nut	Tail	108539	
Nut	As required	86808	1

DESCRIPTION	WESTON PART NO.	QUANTITY PER UNIT
Element - Assembled, Moving, Glide Path Flag Alarm	117987	1
Pointer Assembled	117988	1
Frame - Wound	117985	1
Spring - Paired 30 Total Test	107071	1 pr.
Pivot	88239	2
Nut	22960	2
Weight - Spiral Balance 4 Turns	107381	
Weight - Spiral Balance 6 Turns Side Arms	107382	
Weight - Spiral Balance 8 Turns As required	106356	2
Weight - Spiral Balance 12 Turns	81041	
Nut Tail	108539	
Nut As required	86808	1
Screw - Jewel	106815	8
Spring - Cushion, Right Loc. & Glide Path	117990	2
Spring - Cushion, Left Flag Alarm	121003	2
Spring - Cushion, Right Flag Alarm	121004	2
Spring - Cushion, Left Loc. & Glide Path	123074	2
Screw (Mounting Cushion Springs)	52427	8
Washer - Lock (Mounting Cushion Springs)	27088	8
Plate - Scale, Printed Type 3Y-2	117991	1
Plate - Scale, Printed Type 3Z-2	123586	1
Screw (Mounting Scale Plate)	116863	2
Washer - Lock (Mounting Scale Plate)	30153	2
Spool #68-- Wound 750 Ohms	107645	4
Spool #68 - Wound 5000 Ohms	107652	2
Spool #68 - Wound 1600 Ohms	40419	2
Screw Mounting Spools	102401	8
Lamp - 28 Volt Mazda #313	ND23861	1
Screw (#6-32 x 1" long) (Mtg. Inst. to Panel)	89569	3
Nuts - Tinnerman (#6-32 Thds.) (Mtg. Inst. to Panel)	ND23552	3

5.3.3. OMNI BEARING SELECTOR

(a) Proper Rotation.

(1) The autosyn rotor is rotated in a clockwise direction when the selector knob is rotated clockwise. This also causes the magnetic bearing indicator, as read through the window, to indicate higher numbers as the selector is rotated clockwise. Positioning the TO-FROM toggle does not affect the above.

(2) When flying a course zero degrees TO a VOR station from a position south of that station, a properly connected OBS will cause the Deviation Indicator to deflect right if a course change toward a westerly direction is pursued.

(3) When condition (2) exists, the Deviation Indicator should become centered as the OBS is rotated toward the higher numbers.

(b) Electrical Zero Procedure. (To be employed where the preferred ORZ procedure outlined in paragraph 5.3.5. cannot be followed.)

(1) Autosyn (manual phase shifter).

a. Adjust bearing to read 300 deg. with TO-FROM toggle in counterclockwise position.

b. Apply approximately 26 volt 400 cps to RED (F) rotor lead with Black (E) rotor lead grounded.

c. Rotate autosyn frame in its mount until a minimum voltage is observed between the Red (B) stator and Red (F) rotor (both the Black (A) stator and Black (E) rotor grounded.

d. Next connect meter between Blue (D) and Yellow (C) stator wires and adjust frame for precise null.

e. Without disturbing null achieved in step d., clamp autosyn firmly in its mount.

(c) Winding Resistance.

(1) Autosyn.

a. Rotor should have approximately 230 ohms d-c resistance.

b. Stators should have approximately 170 ohms d-c resistance, and on a given autosyn should agree within 4 ohms d-c of each other.

(2) TO-FROM Meter.

a. This is a 250-0-250 d-c microammeter with a d-c winding resistance of 100 ohms ±20%. With positive voltage applied to pin G the meter deflects toward "TO".

(d) Illumination.

(1) The source of illumination is a 3 volt, 190 millampere bulb, connections to what are provided at pins J and I, with the latter connected to the instrument frame.

(e) Lubrication.

(1) Gear Train.

a. A thin coating (0.005 to 0.010 inch) of ANG-3A grease (or equal is recommended.

(2) Autosyn.

a. If, during a major overhaul inspection, the ball bearings appear dry, one or two drops of AN-O-4 oil (or equal) properly placed should suffice.

(3) Rear Connector Threads.

a. The rear connector threads should be coated lightly with a compound such as DC-4 to facilitate mating connector removal.

5.3.4. OMNI BEARING INDICATOR.

(a) Proper Rotations. - With terminals connected as shown in figure 7-2, shaft rotations will be as follows when facing the omni bearing indicator dial.

(1) Dial will rotate counterclockwise toward larger numbers as a westerly course is pursued from a position south of a VOR station.

(2) Differential autosyn (lower right when facing dial) will rotate clockwise when condition (1) exists.

(3) Autosyn (left side when facing dial) will rotate clockwise when condition (1) exists.

(4) Two-phase motor will rotate counterclockwise when condition (1) exists.

(b) Electrical Zero Procedure.

(1) Differential Autosyn.

a. Connect Blue-Yellow rotor leads (pins L and M).

b. Apply 15 volt 400 cps between leads as connected in a. and the grounded black rotor (K) lead.

c. Temporarily connect Blue-Yellow stator leads (pins H and J).

d. Position rotor for minimum voltage between the connected Blue-Yellow rotor leads and the connected Blue-Yellow stator leads. This minimum should be 2 or 3 volts.

e. Disconnect Blue-Yellow stator leads and carefully adjust rotor position for a null measured between the Blue (H) and Yellow (J) stators.

f. Without disturbing the rotor position with respect to its stators clamp OBI dial to read 180 degrees.

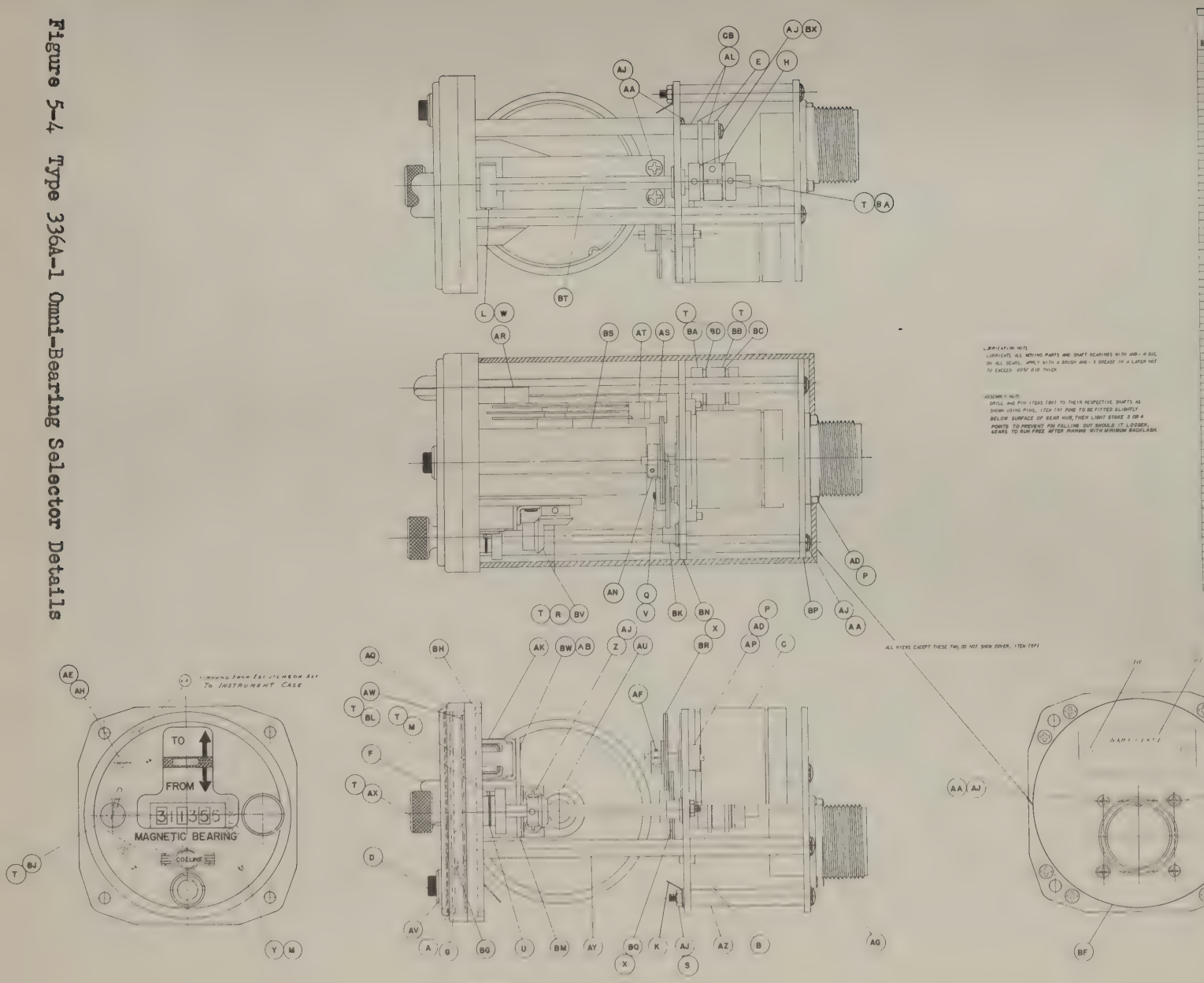


Figure 5-4 Type 336A-1 Omni-Bearing Selector Details

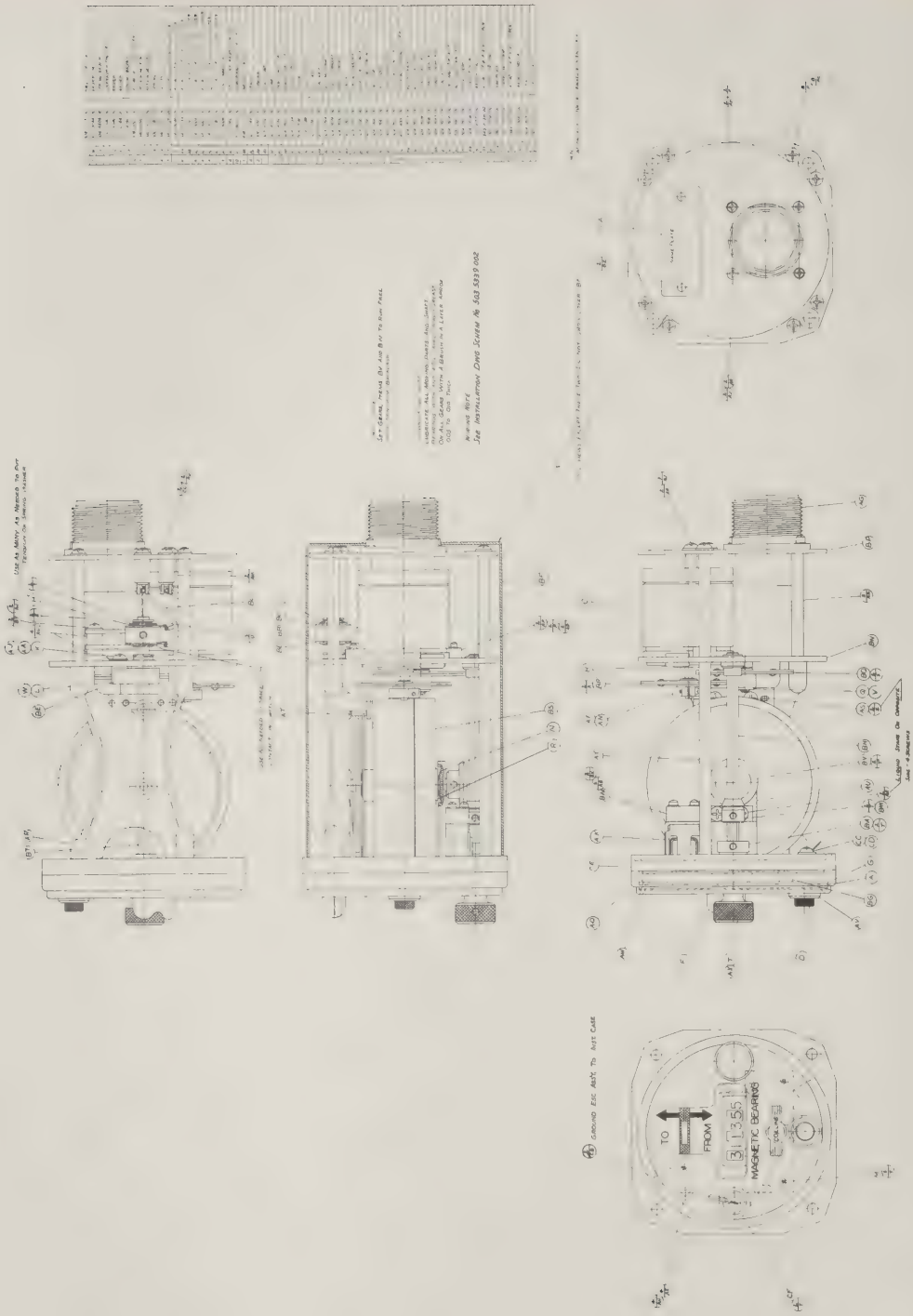
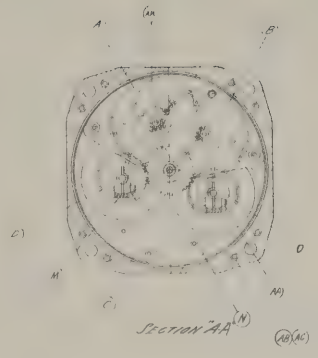
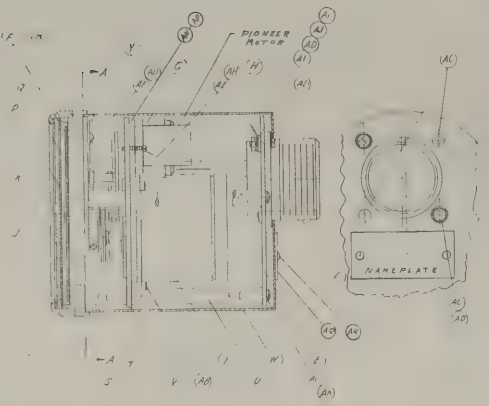


Figure 5-5 Type 336A-2 Omni-Bearing Selector Details





LUBRICATION NOTE:
APPLY AND - A OIL TO ALL SHAFT BEARINGS, AS MUCH AS THEY WILL HOLD BUT NO EXCESS..

ON ALL GEARS, APPLY WITH A BRUSH AND - 3 GREASE IN A LAYER NOT TO EXCEED .005 - .010 THICK..

QUANTITIES LISTED ARE FOR ONE ASSEMBLY					
350	500	503 4686 004	ITEM NO.	PART NUMBER	PART NAME
		1	A	503 4738 001	PINION GEAR ASSY.
		1	B	503 4737 001	PINION GEAR ASSY.
		1	C	503 4742 001	SHAFT GEAR ASSY.
		2	G	503 4739 002	SPRING LOADED GEAR ASSY.
		1	E	503 4744 001	CONNECTOR PLATE ASSY.
		1	F	503 4743 001	DIAL ASSY. (SEE NOTE)
		1	G	230 0107 00	MOTOR (SEE "G" BELOW)
		1	H	230 0077 00	RESOLVER
		1	I	230 0076 00	AUTOSYN
		1	J	302 0206 00	DIAL GASKET
		1	K	192 1003 00	DIAL GLASS
		1	L	357 3003 00	CONNECTOR
		4	M	340 [illegible] 00	SPRING
		4	N	503 4752 001	CLAMP
		2	O	503 4750 001	GEAR CLAMP
		1	P	503 4754 002	HOUSING
		2	Q	503 4734 001	SPL STAND OFF
		1	R	503 4761 003	REAR INSTRUMENT HEAD
		1		503 4760 003	FRONT INSTRUMENT HEAD
		1	T	503 4751 001	SPL STAND OFF
		3	U	503 4735 001	SPL STAND OFF
		1	V	503 4758 002	BEARING PLATE
		1	W	503 4755 002	DUST COVER
		1	X	503 4757 002	BEARING PLATE
		2	AA	321-0187-00	3-56 - 1/4 FIL HD SCREW
		18	AB	321 0006 00	4-40 - 1/4 FIL HD SCREW
		6	AC	343 0134 00	4-40 - 3/16 BD HD SCREW
		4	AD	373 0006 00	#4 SHAKEPROOF (INT)
		2	AE	343 0127 00	2-56 - 1/16 BD HD SCREW
		1	AF	343 0085 00	4-40 - 1/8 BD HD SCREW
		8	AG	310 3240 00	#4 LOCKWASHER
		2	AH	373 8500 00	#2 SHAKEPROOF
		1	AI	304 0015 00	SOLDERING LUG
		1	AJ	313 0043 00	4-40 HEX NUT
		3	AK	373 8010 00	#4 SHAKEPROOF (EXT.)
		1	AL	343 0139 00	4-40 - 3/8 BD HD SCREW
		1	G	503 5433002	MOTOR ASSY (ALTERNATE)
		1	A	520 3905 00	ACC. BAG ASSY.
		1	AM	503 7582 001	GEAR & PINION ASY.
		1	AN	503 7578 001	CENTERLINE BUSHING
		1	AP	503 7579 001	MOTOR SPACER PLATE
		1	AQ	280 0252 00	NAMEPLATE
		2	AR	305 0166 00	RIVET - 1/8 LONG

NOTE.
BEFORE FINAL ASY.. OF ITEM (F).. 3° INCLUDED ANGLE TAPER REAM HOLE IN HUB SO THAT HUB AND END OF SHAFT ARE FLUSH AFTER PRESSING INTO FINAL POSITION.

NOTE:
ONE ACCESSORY BAG ASY.. ITEM (AM) TO BE PACKED WITH EACH INSTRUMENT BEFORE SHIPMENT

Figure 5-6 Type 337A-1 Omni-Bearing Indicator Details

ITEM	QTY	PART NO.	DESCRIPTION	USED ON
-	1	504 3182 001	PINION AND GEAR ASSY.	
-	1	504 3184 001	PINION AND GEAR ASSY.	
-	1	504 3186 001	PINION AND GEAR ASSY.	
-	1	504 3188 001	PINION AND GEAR ASSY.	
-	1	503 4798 002	SPRING LOADED GEAR ASSY.	
-	1	504 3179 001	CONNECTOR PLATE ASSY.	
-	1	503 4743 001	DIAL ASSY. (SEE NOTE)	
-	1	504 3177 001	HOUSING	
-	1	503 4741 001	BEZEL ASSY.	
-	1	336 3078 36	BEZEL	
-	1	336 3078 30	GLASS	
-	1	503 3737 001	CASE ASSY.	
-	1	503 3730 001	CONNECTOR	
-	1	344 [illegible]	SPRING	
-	1	503 3732 001	CLAMP	
-	1	503 3750 001	BRACKET ASSY.	
-	1	503 3754 002	SHAFT	
-	1	501 1134 001	SPL. STANDOFF	
-	1	504 1130 [illegible]	HEAD	
-	1	504 1130 [illegible]	REAR PANEL - METAL	
-	1	501 [illegible]	REAR PANEL - GLASS	
-	1	501 [illegible]	SPL. STANDOFF	
-	1	501 [illegible]	SPL. STANDOFF	
-	1	504 [illegible]	REGISTRATION PLATE - REAR	
-	1	504 [illegible]	REGISTRATION PLATE - FRONT	
-	44	504 1134 001	SPACER WASHER	
-	40	504 1134 001	SPACER WASHER	
0	40	147 [illegible]	4-40 x 3/16 FIL. HD. SCREW	
1	40	147 [illegible]	4-40 x 5/16 FIL. HD. SCREW	
2	40	147 [illegible]	4-40 x 5/16 FIL. HD. SCREW	
3	40	147 [illegible]	4-40 x 5/16 FIL. HD. SCREW	
4	40	147 [illegible]	4-40 x 3/16 FIL. HD. SCREW	
5	40	147 [illegible]	4-40 x 3/16 FIL. HD. SCREW	
6	40	147 [illegible]	4-40 x 3/16 FIL. HD. SCREW	
7	40	147 [illegible]	4-40 x 3/16 FIL. HD. SCREW	
-

g. Recheck null after clamping.

(2) Autosyn (Automatic Phase Shifter). (To be employed where the preferred ORZ Procedure outlined in paragraph 5.3.5. cannot be followed.)

a. Adjust OBI dial and gear train to read 300 degrees against lubber line.

b. Apply approximately 26 volts 400 cps to Red (F) rotor lead with Black (E) rotor lead grounded.

c. Rotate autosyn frame in its mount until a minimum voltage is observed between the Red (B) stator and the Red (F) rotor (both black (A) stator and Black (E) rotor grounded).

d. Next connect meter between Blue (D) and Yellow (C) stators, and adjust for a precise null.

e. Without disturbing null achieved in d. clamp autosyn firmly in its mount.

(c) Motor Rotation.

(1) Direction of Rotation.

a. Connect Black (N) and Blue (S) to low side of a 12-18 volt 400 cycle source.

b. Connect Red (P) to Orange (R) through a 2 microfarad capacitor.

c. Connect the high side of the 12-18 volt 400 cps source to Red (P).

d. Dial should rotate toward decreasing numbers.

(2) Speed.

a. OBI dial should reverse (0 to 180 degrees) in approximately 5 seconds when driven by 51R-2 Receiver servo circuit.

(d) Winding Resistances.

(1) Differential Autosyn.

a. Ohmmeter should indicate approximately 6 ohms d-c resistance between any two rotor leads.

b. Ohmmeter should indicate approximately 6 ohms d-c resistance between any two stator leads.

(2) Autosyn (Automatic Phase Shifter).

a. Rotor should read approximately 230 ohms d.c.

b. Stators should read approximately 170 ohms d.c., and on a given autosyn the two stators should agree within 4 ohms d.c.

(3) Motor.

a. Stators should read approximately 150 ohms d.c. per phase.

(e) Lubrication.

(1) Gear Train.

a. Where very low temperatures are not anticipated, a thin coating (0.005 to 0.010 inch) of AN-G-3A grease (or equal) is recommended.

b. If low temperatures (-30 degrees C., etc.) are anticipated, a thin film of AN-O-4 oil (or equal) is recommended.

(2) Differential Autosyn, Autosyn and Motor.

a. If, during a major overhaul inspection, the ball bearings appear dry, one or two drops of AN-O-4 oil (or equal) properly placed should suffice.

(3) Rear Connector Threads.

a. The rear connector threads should be coated lightly with a compound such as DC-4 to facilitate making connector removal.

5.3.5. OMNI RESOLVER ZERO.

(a) Theory.

(1) The method of setting EZ for resolvers as mentioned in the Eclipse-Pioneer literature will yield an ORZ which is reliable to within approximately $\pm 0.7^{\circ}$. This applies when using the resolver identified as Collins Part No. 230-0077-00 (Eclipse-Pioneer AY-241-5-A or AY-241-5-B). Manufacturing and material variations prevent the EZ from always conforming with the ORZ. The difference between EZ and ORZ is the result of small variations of inductance of the primaries of different resolvers. These irregularities largely stem from variations in the permeability of the laminations in the resolver structure and minute variations in the air gaps between rotor and stators.

(2) If one stator of the above prescribed type of resolver is excited at 30 cps, using a 1000 ohms resistor in series with the generator, it is found that the induced voltage in the rotor leads the generator voltage by approximately 82°. Actually the phase angle of lead has been found to vary from 81.5° to 82.6° in different resolvers.

(3) It having been agreed between the military (USAF) and the commercial aviation interests (ARINC) that the dials of Omni-Bearing Selectors (OBS) and Omni-Bearing Indicators (OBI) read 300° when the resolver zeroing obtains, it is necessary that a prescribed uniform phase shift through a resolver and its associated swamping resistor be achieved. Since the resolver, as used in connection with the omni-range receivers, is a variable phase output device, this uniform phase shift may be achieved by displacing the resolver stator windings from EZ by a slight amount, providing the dial and resolver shaft are held in a fixed position and the resolver is excited in a manner which adequately simulates the excitation system used in the receiver.

(4) The circuit shown in Fig. 5-8 is suitable for adjustment of ORZ. The reference and variable phase generators are those included in Collins 479S-1 or 479S-2 test equipment. They are required only for the initial calibration of the 82.0 degrees network in the calibrating panel. After such initial calibration the signal previously obtained at the variable phase jack may be obtained from any signal generator capable of supplying a 30 cycle signal of about 3 volts into 500 ohms. A recommended generator is Hewlett-Packard 200AR. Other auxiliary equipments required are a Ballantine voltmeter and oscilloscope. These latter two items are used as null detectors. The filter shown is necessary in order that signals harmonically related to 30 cycles and noise may be eliminated in the observation of the nulls obtained. Resistor R1 which is labeled INPUT LEVEL is used to obtain a prescribed signal level at the rotor of the resolver. Resistor R6 is a 10 turn potentiometer used to effect an amplitude balance in the final setting of the resolver frame in an instrument. Phase balance is effected by turning the frame of the resolver. The 82.0 degree shifting network composed of C3-R3-R4-R5-R6-R7 is such that the current in the resistive elements is leading the resolver source voltage by 82.0 degrees. The resistor R12 is a potentiometer used to obtain an amplitude balance during the initial calibration of the panel. It is a screwdriver control which is capable of being locked after setting. Resistor R3 provides a means for adjusting the phase shift obtained in the 82 degree network. It is adjusted in the initial calibration of the panel and locked. It need not be changed after being set.

(5) A detailed examination of the method whereby the two stators of the resolver are excited will show that perfect quadrature excitation is not obtained. The current in the red stator lags the source voltage by about 4 degrees. The current in the blue stator leads the source voltage by about 80 degrees. To be perfectly excited there should be a 90 degree difference in the stator currents and the currents should be equal. Because the ORZ is obtained with the rotor almost completely coupled to the red stator, the fact that the nominally quadrature voltage induced in the rotor by the blue stator is actually near quadrature produces a negligible error. Likewise, slight errors in the amplitude of the current in the blue stators are of negligible importance. It may be concluded then that when the rotor is in the region of full coupling with the red stator, the phase of the output of the rotor is critically dependent only on the circuit components used to feed the red stator.

(b) ORZ Procedure for Calibration of 479X Test Panel.

(1) The procedure for calibrating the panel to be used as a standard for setting ORZ is as follows:

a. Connect the equipment as shown in Fig. 5-8. The variable input signal should be obtained from the variable phase jack on the 479S Test Equipment and the reference signal similarly obtained from the reference phase jack. A 336A Omni-Bearing Selector or a 337A Omni-Bearing Indicator containing a normal resolver, not necessarily calibrated, should be connected through its extension cord to the AN connector on the panel. In the process of obtaining a null in the subsequent steps, it will be found advantageous to start with the gain of the Ballantine voltmeter relatively low, using a constant oscilloscope gain. As a null in voltage is approached, the gain of the Ballantine should be appropriately increased.

b. Turn the selector switch on the panel to the position labeled ROTOR E and turn the INPUT LEVEL control to obtain 0.072 volt on the Ballantine meter. The output jack connecting the Ballantine meter to the filter must be momentarily disconnected for this reading.

c. Reconnect the filter to the Ballantine meter and turn the selector switch to its fourth position labeled CAL E. By alternately adjusting the screwdriver control labeled CAL E and the variable phase dial of the 479S obtain a null indication on the oscilloscope. Note the dial reading on the variable phase dial.

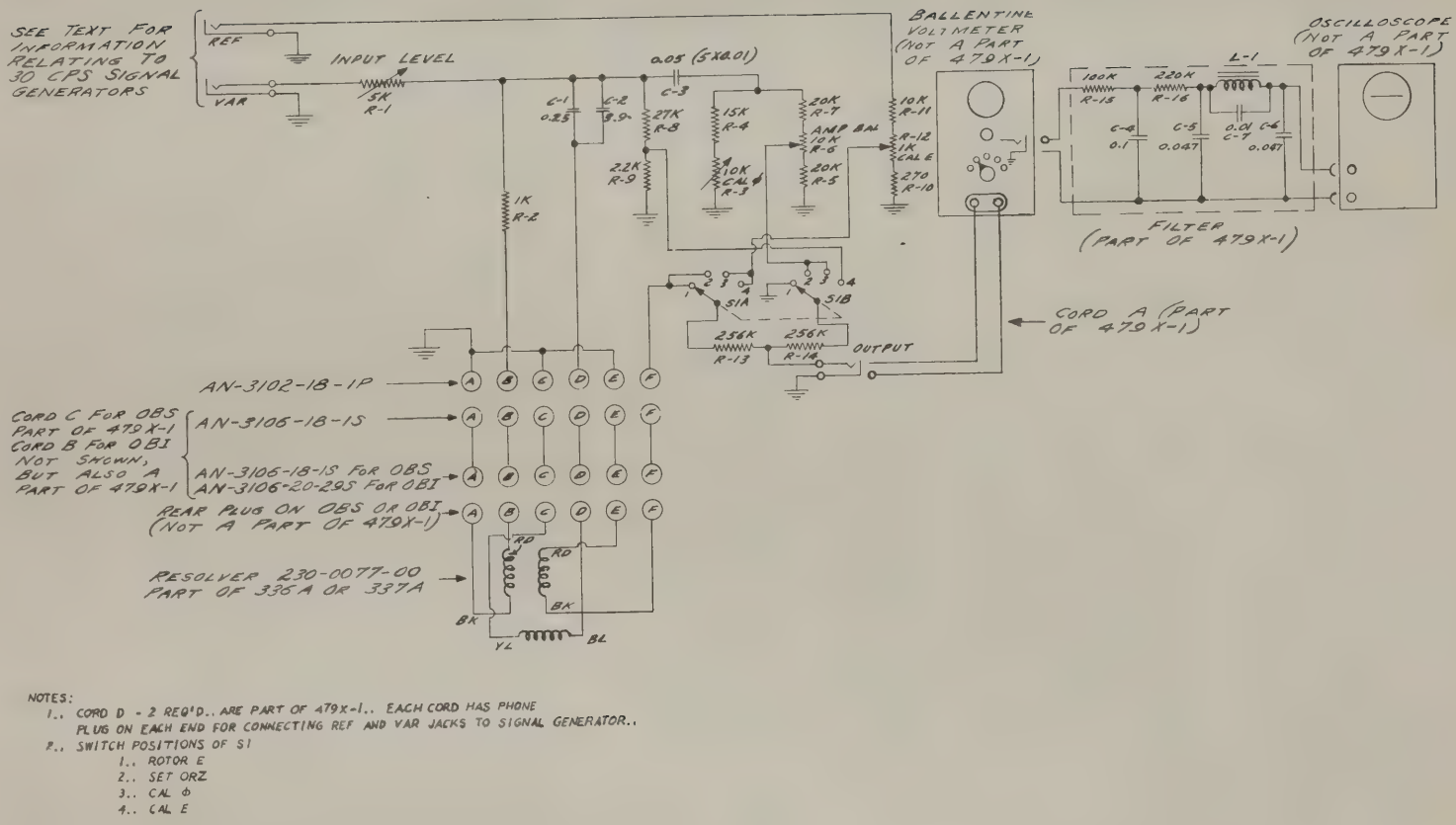
d. Turn the selector switch to its third position labeled CAL Ø. Set the variable phase dial on the 479S to a value which is 82.0 degrees higher than the reading noted in the previous step. Then alternately adjust the control marked AMP BAL and the screwdriver control marked CAL Ø until a null is obtained.

e. Repeat the procedure in paragraph c., above. Note the new variable phase dial reading which might be obtained.

f. Add 82.0 degrees to the newer variable phase dial reading obtained and repeat the procedure in step e. above.

g. Repeat the procedure outlined in steps e. and f. above, until no change in variable phase dial reading is obtained for two similar repeated operations. Then tighten the locking screws on the potentiometer shafts and check to see that the setting has not been disturbed; that is, check to see if the null just obtained persists.

h. A check on the adequacy of the null may be obtained by deliberately changing the variable phase dial of the 479S by 0.1 degree after a null is obtained. A substantial increase in the oscilloscope signal should be obtained.



NOTES:

1.. CORD D - 2 REQ'D.. ARE PART OF 479X-1.. EACH CORD HAS PHONE PLUG ON EACH END FOR CONNECTING REF AND VAR JACKS TO SIGNAL GENERATOR..

2.. SWITCH POSITIONS OF S1

1.. ROTOR E
2.. SET ORZ
3.. CAL ϕ
4.. CAL E

Figure 5-8 479X-1 Omni Resolver Zeroing System

(c) Procedure for setting ORZ on OBS and OBI Instruments.

(1) Having calibrated the panel to serve as an 82.0 degree shifting device, the procedure for adjusting the ORZ of an omni-bearing selector is as follows:

a. The apparatus should be connected as shown in Figure 5-8, except that the variable input may be connected to any 30 cycle generator capable of producing about 3 volts into a 500 ohm load at 30 cycles. The frequency should be within 1% of 30 cycles. Hewlett-Packard type 200AR is one recommended type of generator. No connection need be made to the reference input.

b. With the appropriate connecting cord, connect a 336A Omni-Bearing Selector or a 337A Omni-Bearing Indicator to the AN connector on the panel.

c. With the selector switch on the panel set in the position marked ROTOR E, turn the control marked INPUT LEVEL until a reading of 0.072 volt is obtained on the Ballantine meter. It will be necessary to momentarily disconnect the filter from the voltmeter to obtain the reading.

d. Turn the resolver dial until a reading of exactly 120 is obtained, when the switch on the Omni-Bearing Selector is in its full clockwise position. Set the panel selector switch to the position marked SET ORZ. Loosen the clamps holding the resolver to its mounting plate. Alternately turning the control marked AMP BAL and the frame of the resolver, obtain a null indication on the oscilloscope. Tighten the resolver clamping screws without upsetting the null indication.

(2) All Omni-Bearing Selectors, type 336A-1, and Omni-Bearing Indicators, type 337A-1, have had their zero set by the usual EZ method. All instruments of the type 336A-2 and 337A-2 have had their dials set by a method prescribed in this bulletin, that is, the ORZ method. Users of the instruments, types 336A-1 and 337A-1, may wish to re-zero their instruments by this improved method. It is notable that after setting a resolver by the EZ method, the probable variation from the setting which will be obtained by the ORZ method is of the order of 0.3 degree. Accordingly, it is recommended that users of the 336A-1 and 337A-1 do not readjust the zeroes on their resolvers unless the instrument has been opened for repair or rework for some other reason. All instruments of the type 336A-1 and 337A-1 which have been repaired or reworked by Collins Radio Company since October 1, 1949, have had their dials set to 300 using the ORZ method described herein. Such instruments are marked with letters ORZ on the plate which holds the AN connector. No special markings are employed on 336A-2 or 337A-2.

5.4 SUPPLEMENTARY DATA.

Table 5-1

TYPICAL R-F SENSITIVITY OF 51R-2 VHF RECEIVER

Sensitivity for 1.0 v d.c. on AVC line*

Measured with a Vacuum Tube Voltmeter.

Location	Function	Frequency (mc)	Typical Sensitivity (uv)
Antenna		108-136	3.0
V101.1	R.F. Amplr.	108-136	5.0
V102.1	1st Mixer	19.5-21.4	15
V103.1	Ver. Freq. I-F Ampl.	19.5-21.4	25
V104.1	2nd Mixer	19.5-21.4	150
V104.1	2nd Mixer I-F	3.2	300
V105.1	1st Fixed I-F	3.2	1,500
V106.1	2nd Fixed I-F	3.2	15,000
V107.1	3rd Fixed I-F	3.2	200,000

*With r-f signal at V107.1 to give 1 v AVC on line.

Table 5-2

I-F SELECTIVITY

Conditions of Measurement:

1. 3.2 mc signal, modulated 1000 cps introduced into grid of second mixer.
2. Output - 50 milliwatts..
3. Input raised 2, 10, 100 and 1000 times the input at 3.2 mc as the generator was shifted off resonance an amount sufficient to bring the audio back to 50 m.w.
4. 26.5 volts d.c. input to power supply

DB Change In Input Strength	Frequency In Kilocycles	
1.5	-19.0	+19.2
6.0	-26.9	+25.0
20.0	-41.3	+35.8
40.0	-61.0	+52.5
60.0	-82.0	+72.6
80.0	-108.8	+95.0

Table 5-3

AVC CHARACTERISTIC

Conditions of Measurement:

1. Input - 114.9 mc modulated 30% at 400 cps fed into antenna terminal.
2. Input level - varied from 1 microvolt to 100,000 microvolts.
3. 26.5 v d.c to power supply.

Input Signal Microvolts	Audio Output mw	Audio Output Rel Db	DB Power Change from 250 mw	% Distortion and Noise
1	5	7.0	-16.3	47
3	70	18.5	- 4.8	23.5
5	130	21.0	- 2.3	14.5
7	145	21.3	- 2.0	12.0
10	155	21.7	- 1.6	9.3
30	180	22.3	- 1.0	5.8
100	200	23.0	- 0.3	6.5
300	205	23.1	- 0.2	6.5
1,000	220	23.3	0	6.5
3,000	220	23.3	0	7.3
10,000	230	23.4	0.1	7.3
30,000	235	23.6	0.3	8.2
100,000	240	23.8	0.5	9.3

Table 5-4

A-F RESPONSE

Conditions of Measurements:

1. Input - 1000 microvolts fed into antenna terminal. Frequency varied from 30 to 10,000 cps. Percentage of modulation held constant.

2. 28 v d.c. to power supply.

At 108 mc* DB	Output Rel DB	Audio Freq. in cycles	At 131.8 mc* DB	Output Rel DB
-28.0	-54.6	30	-19.0	-44.0
- 4.0	-30.0	90	- 2.0	-27.6
- 4.0	-30.0	100	0.5	-25.1
- 2.0	-28.0	150	7.7	-17.9
4.0	-22.6	200	11.5	-14.1
21.0	- 5.6	300	23.9	- 2.1
24.6	- 1.9	400	24.3	- 1.7
25.7	- 0.8	600	24.2	- 1.4
26.3	- 0.3	800	25.0	- 0.6
26.6	0	1,000	25.6	0
26.5	- 0.1	1,250	26.0	0.4
25.7	- 0.8	2,000	25.8	0.2
23.0	- 3.6	3,500	25.9	0.3
19.5	- 7.1	5,000	20.0	- 5.6
6.0	-20.6	10,000	8.0	-17.0

* At 108 megacycles input modulated 30%, while 131.8 megacycles modulated 100%.

Table 5-5

TYPICAL RECEIVER SENSITIVITY AND S/N RATIO

Specification limits 200 mw output at 3 uv or less with not less than a 6 db S/N ratio. Measurements made at 25°C.

Frequency (mc)	Input uv	Output mw	S/N
110.1	1.9	200	6.5
114.9	1.9	200	6.5
131.8	1.5	200	7.0

Table 5-6

MISCELLANEOUS PERFORMANCE DATA

I. Typical Bearing Accuracy employing precision OBS (Collins 479). Specification limit ±0.5 OBS; ±1.0 OBI. Measurements made at 25°C.

TEST Gen.	OBS	OBI
0	0.2	0
30	0	-0.5
60	0.2	0
90	0.2	0.5
120	0.1	0
150	-0.2	-1.0
180	-0.4	-1.0
210	-0.2	-0.5
240	0.2	0.5
270	0.4	1.0
300	0.2	0.5
330	0.1	0.
360	0.1	0.

II. Typical Bearing Change vs. RF Level (0° from Station) at 25°C. Error referred to 1000 uv bearing. Specification limits ±0.5 deg. for OBS or OBI.

	5 uv	1000 uv	50K uv	100K uv
OBS	0.5	0	-0.3	-0.3
OBI	0.5	0	0	0

III. Typical Bearing Change vs. Primary Supply (A^+) Variation. Specification limits ±0.5 deg. for OBS or OBI. Measured at 0 deg. from station. Error referred to 1000 uv bearing. Temperature 25° C .

	23.8V	26.5	29.2
OBS	-0.2	0	0.1
OBI	0	0	0

IV. Typical Bearing Change vs. Modulation Level Change. Specification limits ±0.5 deg. for OBS or OBI. Measured at 0 degrees from station. Error referred to normal percentage modulation. Temperature 25°C.

	-25%	Normal	+25%
OBS	0.2	0	-0.1
OBI	0	0	0

Table 5-7

INSTRUMENTATION CIRCUITS SOCKET VOLTAGES

All maintenance procedures and measurements are based on the following test signals and conditions unless otherwise stated:

RF input - 1000 uv at either 110.1 or 114.9 mc.

VOR signal - 30% 9960 FM plus 30% 30 cps.

Tone Loc - 20% 90 cps plus 20% 150 cps.

Phase Loc - 30% 9960 FM only on course; 30% 9960 FM plus 7-1/2% 30 cps to provide a 90 ua deviation indicator deflection.

D.C. input - 26.5 volts.

A.C. input - 26.0 volts, 400 cps.

A.C. Voltage Measurements - Obtained using Ballantine Model 300 voltmeter with a short unshielded input lead having negligible capacitance.

D.C. Voltage Measurements - D.C. VTVM having an input impedance not less than 10 megohms.

Phase Angle - Phase angles of reference channel are compared against the variable signal from 479S-2. Variable channel phase angles are compared against reference signal from 479S-2. No filters employed. Model 208B Dumont Scope or equivalent.

Test Generator (Audio) - Collins 479S-1

Test Generator (RF) - Boonton 211-A

Socket No.	Pin No.	A.C. Voltage	A.C. Frequency	D.C. Voltage	Phase Angle
V115	1			245.0	
	2	4.5	30 ~		7.0
	3	3.5	30 ~	9.5	7.0
	4			6.0	
	5			6.0	
	6	6.0	9960	88.0	
	7	.52	9960		
	8			2.8	
	9			12.0	

Table 5-7 (Cont.)

Socket No.	Pin No.	A.C. Voltage	A.C. Frequency	D.C. Voltage	Phase Angle
V116	1			245.0	
	2	6.0	9960		
	3			6.0	
	4			6.0	
	5			6.0	
	6	10.0	9960	235.0	
	7				
	8			6.0	
	9			12.0	
V117	1	5.4	9960	240.0	
	2				
	3			8.4	
	4			20.5	
	5			20.5	
	6			245.0	
	7	10.0v	9960		
	8			8.4	
	9			14.5	
V118	1			245.0	
	2	4.6	30~		187.0
	3	3.5	30~	10.0	187.0
	4			20.5	
	5			20.5	
	6	32.0	9960	242.0	
	7	4.0	9960		
	8			8.8	
	9			14.5	
V119	1	0.31	30~	35.0	
	2	0.044	30~		70.0
	3			1.7	
	4			20.5	
	5			20.5	
	6	3.5	30~	35.0	70.0
	7	0.31	30~		
	8			1.65	
	9			26.5	

Table 5-7 (Cont.)

Socket No.	Pin No.	A.C. Voltage	A.C. Frequency	D.C. Voltage	Phase Angle
V120	1	35.0	30~	240.0	70.0
	2	3.0	30~		250.0
	3			9.5	
	4			20.5	
	5			20.5	
	6	35.0	30~	240.0	250.0
	7	3.0	30~		70.0
	8			9.5	
	9			26.5	
V121	1	3.0	30~	95.0	199.5
	2	0.29	30~		22.0
	3			1.3	
	4			20.5	
	5			20.5	
	6	3.0	30~	30.0	21.0
	7	0.27	30~		201.5
	8			1.3	
	9			26.5	
V122	1	30.0	30~	240.0	203.0
	2	3.0	30~		24.0
	3			9.5	
	4			20.5	
	5			20.5	
	6	30.0	30~	240.0	23.0
	7	3.0	30~		202.2
	8			9.5	
	9			26.5	
V123	1	0.31	30~	35.0	
	2	.044	30~		70.0
	3			1.6	
	4			20.5	
	5			20.5	
	6	3.2	30~	35.0	70.0
	7	0.31	30~		
	8			1.8	
	9			14.5	

Table 5-7 (Cont.)

Socket No.	Pin No.	A.C. Voltage	A.C. Frequency	D.C. Voltage	Phase Angle
V124	1	38.0	30~	145.0	
	2	2.9	30~	3.6	250.0
	3	2.2	30~	13.5	202.2
	4			20.5	
	5			20.5	
	6	38.0	30~	145.0	
	7				70.0
	8	2.2	30~	13.5	202.2
	9			14.5	
V125	1	9.0		150.0	
	2	38.0	30~		
	3			58.0	
	4			20.5	
	5			20.5	
	6	9.0		150.0	
	7	38.0	30~		
	8			58.0	
	9			26.5	
V126	1	5.0	60~	150.0	
	2	5.0	60~		
	3	2.7	60~	5.5	
	4			20.5	
	5			20.5	
	6			245.0	
	7	3.0	30~		202.2
	8	2.1	30~	13.5	202.2
	9			26.5	

5.5 ADJUSTMENT AND SELECTION OF CRITICAL COMPONENTS.

Transformer T114 is resonated by Capacitor C167 plus a small capacitor C193. To properly resonate this transformer, an oscilloscope observation should be made across R189 to ground. That is, an in-phase condition should be obtained at the left hand end of R189 and by adjustment of C193 an in-phase condition again obtained at terminal 6 of T114. The input impedance to the

oscilloscope used in making this adjustment should be not less than 2 megohms. Transformer T114 should be resonated to approximately 1% of exact resonance or to within the nearest 100 uufd of resonance.

Transformer T115 is resonated as follows: With an oscilloscope which is known to have zero phase shift between the two input terminals (a scope of the quality required to perform an interference pattern VOR zero test will be satisfactory), a condition of 180 degrees should be accurately established between terminal 6 of T114 and terminal 3 of T115. This can be done by connecting the vertical plates to terminal 6 of T114 and the horizontal plates to terminal 3 of T115, and adjusting C169 until the out of phase condition exists. This transformer should be resonated to within the nearest .01 mfd of exact resonance.

Transformer T116 is adjusted to resonance in a manner identical to that described above for T115. Observation points in the case of T116 are grid 7 and plate 6.

Transformer T117 is adjusted for resonance exactly as outlined for transformer T114. It should also be adjusted to within the nearest 100 uuf of exact resonance.

Resistor R221 is adjusted to establish approximately 2.1 ma plate current flowing from the combined triodes of V125. This adjustment is made after it has been ascertained that normal VOR signals exist in the automatic circuit.

OBI index control R219 is used as a zeroing control to adjust the omni-bearing indicator to the proper bearing as determined by the VOR test equipment.

VOR zero control R194 is adjusted to balance the crosspointer indication when the VOR test equipment and the omni-bearing selector are adjusted to a bearing of 100 degrees from the station. At this point tracking controls R181 and R203 have no effect on the VOR bearing.

Tracking controls R181 and R203 are adjusted as follows: With the VOR test equipment set to 100.0 degrees, the omni-bearing selector set to 100.0 degrees FROM, adjust R194 for zero crosspointer deviation. Adjust the omni-bearing indicator centering pot R219 to 280.0 degrees as indicated on the omni-bearing indicator. Reset the VOR test equipment to 160 degrees. Reset the omni-bearing selector to 160.0 degrees FROM. Adjust the omni-bearing selector tracking control R181 to zero crosspointer deviation. Adjust the omni-bearing indicator tracking pot R219 to 340 degrees as indicated on the omni-bearing indicator. This procedure will usually yield an error curve in the order of ± 0.5 degrees for the omni-bearing selector after the first trial. This should yield an OBI tracking error of no greater than ± 1.0 degrees. Greater accuracy may be obtained by repeating the procedure. Errors present in the VOR test equipment and resolvers used in the test omni-bearing selector limit the accuracy to approximately ± 0.3 degrees.

VOR course width is controlled by potentiometer R239 which is in series with the rectified output of E102 and deviation indicator. Adjustment of this control will not affect the VOR bearing. Pot R238 which is also in series with R239 is used to adjust the deflection sensitivity of phase localizer. It will be noted that R238 is automatically short-circuited when the receiver is tuned to VOR frequencies. Thus, adjustment of R238 has no effect on VOR course width and adjustment of R239, since this potentiometer is a small fraction of R238 and has a negligible effect on phase localizer deflection sensitivity.

Potentiometer R245 controls the signal input and hence the deflection sensitivity of deviation indicator when the receiver is used on tone localizer facilities. The flag sensitivity on this facility has been adjusted properly to accommodate 20-20% modulation and deflection sensitivities in the order of 90 ua for 4 db tone differential.

Potentiometer R234 is a phase detector balance control and is used to compensate for slight tolerance variations in the components used in the metering circuit. To properly balance this control, the receiver should be set up for normal VOR operation, and the OBS adjusted for balanced deviation indicator reading with an input of 1000 uv 114.9 mc 30% 9960 FM only. Proper adjustment of R234 on a 9960 FM signal will automatically set up the necessary balance conditions for phase localizer.

Potentiometer R236 is utilized to obtain course balance on the tone localizer. Adjustment of R236 should follow that of R234 although the minute adjustments required in R234 have in general a negligible effect on tone localizer balance.

The aural output of the receiver is controlled by pot R156 located in the grid circuit of the final audio amplifier. RF sensitivity control R103 is located in the cathode circuit of V101 and will normally be adjusted for full clockwise or maximum sensitivity position.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
B101	Autopositioner	MOTOR: DC, PM; 27.5 vdc input, 1200 rpm	503 5082 002
	(Replacement for B101)	BRUSH: 2 per motor	234 0188 00
C101	RF amp AVC filter	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C102	RF amp grid coupling	CAPACITOR: ceramic, 10 mmf ± 1/4 mmf, 500 WV	913 0528 00
C103	RF amp cathode bypass	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0420 00
C104	RF amp screen bypass	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0420 00
C105	RF amp plate bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C106	1st mixer grid coupling	CAPACITOR: Ceramic, 24 mmf ± 5%, 500 WV	916 4428 00
C107	1st mixer - oscillator coupling	CAPACITOR: ceramic, 2.2 mmf ± 20%, 500 WV	913 0390 00
C108	1st mixer cathode	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0420 00
C109	1st mixer screen bypass	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0420 00
C110	1st mixer screen voltage filter	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C111	Variable IF amp AVC filter	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C112	Variable IF amp grid coupling	CAPACITOR: ceramic, 10 mmf ± 20%, 500 WV	913 0528 00
C113	Variable IF amp cathode bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C114	Variable IF amp screen bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C115	Variable IF amp plate bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C116	2nd mixer AVC filter	CAPACITOR: paper, 4700 mmf ± 10%, 200 WV	931 0345 00
C117	2nd mixer grid coupling	CAPACITOR: ceramic, 24 mmf ± 5%, 500 WV	916 4428 00
C118	2nd mixer screen bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C119	2nd mixer plate bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C120	1st fixed IF amp AVC filter	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C121	1st fixed IF amp grid coupling	CAPACITOR: ceramic, 10 mmf ± 1/4 mmf, 500 WV	913 0528 00
C122	1st fixed IF amp cathode bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C123	1st fixed IF amp screen bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C124	1st fixed IF amp plate bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C125	2nd fixed IF amp cathode bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C126	2nd fixed IF amp grid coupling	CAPACITOR: ceramic, 4.7 mmf ± 20%, 500 WV	913 0392 00
C127	2nd fixed IF amp plate bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C128	3rd fixed IF amp cathode bypass	CAPACITOR: paper, 10,000 mmf ± 20%, 300 WV	931 0364 00
C129	3rd fixed IF amp screen bypass	CAPACITOR; paper, 10,000 mmf ± 20%, 300 WV	931 0364 00
C130	IF amp plate supply filter	CAPACITOR: paper, 10,000 mmf ± 20%, 300 WV	931 0364 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C132	HF injection osc cathode bypass	CAPACITOR: mica, 220 mmf ± 10%, 500 WV	912 0519 00
C133	HF injection osc feedback coupling	CAPACITOR: ceramic, 20 mmf ± 2%, 500 WV	916 4054 00
C134	HF injection osc screen bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C135	HF injection multiplier grid coupling	CAPACITOR: ceramic, 15 mmf ± 2%, 500 WV	913 0534 00
C136	HF injection multiplier cathode bypass	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0420 00
C137	HF injection multiplier screen bypass	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0420 00
C138	RF B+ supply filter	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0301 00
C139	LF injection osc output tank	CAPACITOR: silver mica, 1000 mmf ± 5%, 500 WV	912 0393 00
C140	LF injection osc plate bypass	CAPACITOR: paper, 10,000 mmf ± 20%, 300 WV	931 0364 00
C141	LF injection osc screen voltage filter	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C142	LF injection osc screen bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00
C143	LF injection osc cathode bypass	CAPACITOR: mica, 220 mmf ± 10%, 500 WV	912 0519 00
C144	LF injection osc feedback coupling	CAPACITOR: ceramic, 20 mmf ± 2%, 500 WV	916 4054 00
C145	Detector output filter	CAPACITOR: mica, 100 mmf ± 10%, 500 WV	912 0495 00
C146	Detector cathode bypass	CAPACITOR: ceramic, 1500 mmf ± 20%, 350 WV	913 0393 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C147		CAPACITOR: paper, 3 x .5 mf ± 20%, 100 WV	931 0030 00
C147A	AVC filter	CAPACITOR: section of C147, .5 mf	
C147B	Audio AVC bypass	CAPACITOR: section of C147, .5 mf	
C147C	V109 cathode	CAPACITOR: section of C147, .5 mf	
C148		CAPACITOR: not used	
C149	V109 grid	CAPACITOR: paper, .1 mf ± 10%, 200 WV	931 0333 00
C150	V110 grid	CAPACITOR: mica, 470 mmf ± 10%, 500 WV	912 0543 00
C151	V110 squelch cathode	CAPACITOR: mica, 470 mmf ± 10%, 500 WV	912 0543 00
C152	V110 squelch coupling	CAPACITOR: paper, 10,000 mmf ± 20%, 300 WV	931 0364 00
C153	V110 squelch	CAPACITOR: paper, .1 mf ± 10%, 200 WV	931 0333 00
C154	V110 squelch plate coupling	CAPACITOR: paper, 10,000 mmf ± 20%, 300 WV	931 0364 00
C155	Audio output filter	CAPACITOR: paper, 4700 mmf ± 10%, 200 WV	931 0345 00
C156	Reference channel coupling	CAPACITOR: mica, 1,000 mmf ± 20%, 300 WV	935 5012 00
C157	1st limiter grid coupling	CAPACITOR: mica, 470 mmf ± 10%, 500 WV	912 0543 00
C158	Limiter coupling	CAPACITOR: mica, 470 mmf ± 10%, 500 WV	912 0543 00
C159	V118 coupling	CAPACITOR: mica, 1000 mmf ± 20%, 300 WV	935 5012 00
C160	Filter section tuning	CAPACITOR: mica, 1100 mmf ± 2%, 300 WV	935 5013 00
C161	Filter section tuning	CAPACITOR: mica, 56 mmf ± 10%, 500 WV	912 0477 00
C162	Reference channel rectifier filter	CAPACITOR: mica, 5600 mmf ± 5%, 500 WV	935 2376 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C163	OBS Resolver amplifier grid coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C164	OBS Resolver amplifier grid coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C165	V119 coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C166	V119 output coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C167	V120 grid tuning	CAPACITOR: mica, 10,000 mmf ± 2 %, 300 WV	935 2391 00
C168	Tune primary of T115 to 30 cycles	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
*C169	Fine tuning of T115	CAPACITOR:	
C170	Variable channel input coupling	CAPACITOR: paper, .50 mf ± 10%, 400 WV	930 0069 00
C171		CAPACITOR: paper, 3 x .5 mf ± 20%, 100 WV	931 0030 00
C171A	V110 audio output cathode	CAPACITOR: section of C171, .5 mf	
C171B	V124 grid circuit bypass	CAPACITOR: section of C171, .5 mf	
C171C	V121 AVC decoupling filter	CAPACITOR: section of C171, .5 mf	
C172	Z103 filter tuning	FILTER ASSEMBLY, tuner: includes nine 10,000 mmf ± 2%, 300 WV capacitors	504 2853 001
C173		CAPACITOR: paper, dual section, +40 -15%, 400 WV 2 x .5 mf	961 7203 00
C173A	V121 plate supply decoupling	CAPACITOR: .5 mf, section of C173	
C173B	V123 plate supply decoupling	CAPACITOR: .5 mf, section of C173	

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C174	Variable phase amplifier coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C175	Variable phase amplifier coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C176	Tune T113 primary	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
*C177	Fine tuning of T113 primary	CAPACITOR:	
C178	V123, OBI amp coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C179	V123 coupling	CAPACITOR: paper, .25 mf ± 10%, 400 WV	930 0089 00
C180	V124 grid circuit tuning	CAPACITOR: mica, 10,000 mmf ± 2%, 300 WV	935 2391 00
C181	V126 plate HF bypass	CAPACITOR: mica, 470 mmf ± 10%, 500 WV	912 0543 00
C182	V124, V125 coupling	CAPACITOR: paper, 33,000 mmf ± 20%, 300 WV	931 0373 00
C183	V124, V125 coupling	CAPACITOR: paper, 33,000 mmf ± 20%, 300 WV	931 0373 00
C184	V125 cathode bypass	CAPACITOR: dry electrolytic, 25 mf, 100 WV	184 6525 00
C185	T118 reactor shunt	CAPACITOR: paper, 2 mf -20 + 30%, 100 WV	931 0034 00
C186	T118 reactor shunt	CAPACITOR: paper, 2 mf -20 + 30%, 100 WV	931 0034 00
C187	Motor control	CAPACITOR: paper, 2 mf -20 + 30%, 100 WV	931 0034 00
C188	TO-FROM phase splitting	CAPACITOR: paper, .5 mf ± 10%, 600 WV	930 0130 00
C189	V126 regulator circuit	CAPACITOR: paper, 33,000 mmf ± 20%, 300 WV	931 0373 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C190	V119 plate decoupling	CAPACITOR: paper, 1 mf ± 10%, 600 WV	930 0080 00
C191	Motor capacitor	CAPACITOR: paper, 0-2 mf ± 20%, 120 WV	931 0151 00
C192	Filament RF by-pass	CAPACITOR: silver mica, 500 mmf ± 20%, 500 WV	912 0301 00
*C193	V120 grid fine tuning	CAPACITOR:	
*C194	V124 grid circuit fine tuning	CAPACITOR:	
E101	30 cycle AM demodulator	RECTIFIER: selenium bridge, consists of four assemblies	353 0038 00
E102	Deviation indicator supply	RECTIFIER: double bridge; copper oxide	353 0014 00
E103	TO-FROM indicator supply	RECTIFIER: crystal; germanium; min forward cur 3 ma at 1 v; max reverse cur 1 ma at 50 v	353 0011 00
E104	TO-FROM indicator supply	RECTIFIER: crystal; germanium; min forward cur 3 ma at 1 v; max reverse cur 1 ma at 50 v	353 0011 00
E105	Rear plug spare pin	BOARD, terminal: 8 solder term staked on board	504 2852 001
E106		BOARD, terminal: 4 solder term staked on board	503 5064 001
E107		BOARD, terminal: 4 solder term staked on board	503 5065 001
I101		LAMP, neon: 1/25 w	262 0025 00
I102		LAMP, neon: 1/25 w	262 0025 00
J101		CONNECTOR: single female contact, wall mtg	357 9003 00
K101	Autopositioner control	RELAY, autopositioning operating: single contact, NO; 26.5 vdc coil	503 5115 00
K102	Autopositioner control	RELAY, autopositioning operating: single contact, NO; 26.5 vdc coil	503 5115 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
K103	Autopositioner control	RELAY: armature, contact rating 3 amp, 150 v AC	410 0062 00
K104	AVC VOR filter disabling	RELAY: circuit control; 1 pole NO, 1 pole NC, 32.0 v max coil	972 1163 00
K105	Phase-Tone localizer relay	RELAY: rotary, DC operating voltage 32 v max	410 0070 00
L101	HF injection osc cathode	COIL, RF CHOKE: .5 mh	503 4535 001
L102	LF injection osc cathode	COIL, RF CHOKE: .5 mh	503 4535 001
P101	Receiver connector	CONNECTOR, male contact: 45 term; wall mtg	370 2033 00
R101	RF amp grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R102	RF amp cathode	RESISTOR: 220 ohm ± 10%, 1/2 w	745 1058 00
R103	R.F. gain control	RESISTOR: variable, 5000 ohm, linear, 1 w, 100 WV	376 0053 00
R104	1st mixer grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R105	1st mixer cathode	RESISTOR: 1000 ohm ± 10%, 1/2 w	745 1086 00
R106	1st mixer screen	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R107	1st mixer plate	RESISTOR: .22 megohm ± 10%, 1/2 w	745 1184 00
R108	Var. freq. IF amp grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R109	Var. freq. IF amp cathode	RESISTOR: 1000 ohm ± 10%, 1/2 w	745 1086 00
R110	Var. freq. IF amp screen	RESISTOR: 3300 ohm ± 10%, 1/2 w	745 1107 00
R111	Var. freq. IF amp plate	RESISTOR: 33,000 ohm ± 10%, 1/2 w	745 1149 00
R112	2nd mixer grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R113	2nd mixer cathode	RESISTOR: 3300 ohm ± 10%, 1/2 w	745 1107 00
R114	2nd mixer screen	RESISTOR: .22 megohm ± 10%, 1/2 w	745 1184 00
R115	2nd mixer plate	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R116	1st fixed IF amp grid	RESISTOR: .22 megohm ± 10%, 1/2 w	745 1184 00
R117	1st fixed IF amp cathode	RESISTOR: 3300 ohm ± 10%, 1/2 w	745 1107 00
R118	1st fixed IF amp plate	RESISTOR: 33,000 ohm ± 10%, 1/2 w	745 1149 00
R119	2nd fixed IF amp grid	RESISTOR: .22 megohm ± 10%, 1/2 w	745 1184 00
R120	2nd fixed IF amp cathode	RESISTOR: 3300 ohm ± 10%, 1/2 w	745 1107 00
R121	2nd fixed IF amp plate	RESISTOR: 33,000 ohm ± 10%, 1/2 w	745 1149 00
R122	3rd fixed IF amp cathode	RESISTOR: 1200 ohm ±10%, 1/2 w	745 1090 00
R123	Current limiting for V114	RESISTOR: 12,000 ohm ± 10%, 2 w	745 9143 00
R124	Current limiting for V114	RESISTOR: 12,000 ohm ± 10%, 2 w	745 9143 00
R125	RF screen voltage dropping	RESISTOR: 6800 ohm ± 10%, 1/2 w	745 1121 00
R126	RF plate voltage dropping	RESISTOR: 2200 ohm ± 10%, 2 w	745 9111 00
R127	3rd fixed IF amp plate	RESISTOR: 18,000 ohm ± 10%, 1/2 w	745 1139 00
R128	H.F. injection osc grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R129	H.F. injection osc cathode	RESISTOR: 150 ohm ± 10%, 1/2 w	745 1051 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PARTS NUMBER
R130	H.F. injection osc screen	RESISTOR: 56,000 ohm ± 10%, 1/2 w	745 1160 00
R131	HF injection multiplier grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R132	HF injection multiplier cathode	RESISTOR: 220 ohm ± 10%, 1/2 w	745 1058 00
R133	HF injection multiplier screen	RESISTOR: 47,000 ohm ±10%, 1/2 w	745 1156 00
R134	RF & OSC section B + decoupling	RESISTOR: 2200 ohm ± 10%, 2 w	745 9111 00
R135	LF injection osc. screen	RESISTOR: 47,000 ohm ± 10%, 1/2 w	745 1156 00
R136	LF injection osc. plate	RESISTOR: 3300 ohm ± 10%, 1/2 w	745 1107 00
R137		RESISTOR: Not used	
R138	LF injection osc screen	RESISTOR: 3300 ohm ± 10%, 1/2 w	745 1107 00
R139	LF injection osc cathode	RESISTOR: 150 ohm ± 10%, 1/2 w	745 1051 00
R140	LF injection osc grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R141	Detector load	RESISTOR: 100K ohm ± 5%, 1/4 w	745 1169 00
	Not used		
R143	Diode detector cathode voltage divider	RESISTOR: 6800 ohm ± 5%, 1/2 w	745 0120 00
R144	Diode detector cathode voltage divider	RESISTOR: 68,000 ohm ± 5% 1/2 w	745 1162 00
R145	AVC load	RESISTOR: .22 megohm ± 10%, 1/2 w	745 1184 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R146	AVC filtering	RESISTOR: .33 megohm ± 10%, 1/2 w	745 1191 00
R147	AVC filtering	RESISTOR: .33 megohm ± 10%, 1/2 w	745 1191 00
R148		RESISTOR: Not used	
R149	V109 limiter grid	RESISTOR: 1 megohm ± 10%, 1/2 w	745 1212 00
R150	V109 limiter cathode	RESISTOR: 1500 ohm ± 10%, 1/2 w	745 1093 00
R151	V109 audio amplifier cathode voltage divider	RESISTOR: 6800 ohm ± 10%, 1/2 w	745 1121 00
R152	Not used		
R153	V109 audio amplifier cathode voltage divider	RESISTOR: 27,000 ohm ± 10%, 1/4 w	745 0146 00
R154	V109 audio amp grid	RESISTOR: .22 megohm ± 10%, 1/2 w	745 1184 00
R155	V109 audio amp plate	RESISTOR: 47,000 ohm ± 10%, 1/2 w	745 1156 00
R156	Volume control, V110 grid	RESISTOR: variable, 50,000 ohm ± 20%, 1 w	376 0056 00
R157	V110 audio output cathode	RESISTOR: 820 ohm ± 10%, 1/2 w	745 1083 00
R158	V110 audio output grid	RESISTOR: .10 megohm ± 10%, 1/2 w	745 1170 00
R159	V110 audio output grid	RESISTOR: .33 megohm ± 10%, 1/4 w	745 1191 00
R160	V110 squelch cathode	RESISTOR: .27 megohm ± 10%, 1/2 w	745 1188 00
R161	V110 squelch grid	RESISTOR: .27 megohm ± 10%, 1/2 w	745 1188 00
R162	V110 squelch grid	RESISTOR: .27 megohm ± 10%, 1/2 w	745 1188 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R163	Reference channel band pass filter	RESISTOR: 82,000 ohm ± 10%, 1/4 w	745 0167 00
R164	V115 grid	RESISTOR: .10 megohm ± 10%, 1/4 w	745 0170 00
R165	V115 limiter cathode	RESISTOR: 1000 ohm ± 10%, 1/4 w	745 0086 00
R166	V115 limiter plate	RESISTOR: 56,000 ohm ± 10%, 1/4 w	745 0160 00
R167	V116 grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R168	V116 cathode	RESISTOR: 6800 ohm ± 10%, 1/4 w	745 0121 00
R169	V116 plate	RESISTOR: 56,000 ohm ± 10%, 1/4 w	745 0160 00
R170	V117 grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R171	V117 cathode	RESISTOR: 6800 ohm ± 5%, 1/4 2 w	745 0120 00
R172	V117 plate	RESISTOR: 56,000 ohm ± 5%, 1/4 w	745 0159 00
R173	Part of anti-resonant filter	RESISTOR: 27,000 ohm ± 10%, 1/4 w	745 0146 00
R174	V118 Disc. amp cathode	RESISTOR: 1000 ohm ± 10%, 1/4 w	745 0086 00
R175	Not used		
R176	Reference Channel rectifier load	RESISTOR: .47 megohm ± 10% 1/4 w	745 0198 00
R177	OBS Resolver amp. grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R178	OBS Resolver amp. grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R179	Resolver input swamping, OBS	RESISTOR: wire-wound, 1500 ohm ± 5%, 1/2 w	708 0115 00
R180	Resolver input swamping, OBI	RESISTOR: wire-wound, 1500 ohm ± 5%, 1/2 w	708 0115 00
R181	Tracking control	RESISTOR: variable, 25,000 ohm ± 20%, 1 w	376 0055 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R182	V119 cathode	RESISTOR: 3300 ohm ± 10%, 1/4 w	745 0107 00
R183	V119 cathode	RESISTOR: wire-wound, 33 ohm ± 5%, 1/2 w	707 0175 00
R184	V119 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00
R185	V119 grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R186	V119 cathode	RESISTOR: 3300 ohm ± 10%, 1/4 w	745 0107 00
R187	V119 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00
R188	Reference amplifier feedback	RESISTOR: 1 megohm ± 10%, 1/4 w	745 0212 00
R189	Frequency compensation for OBS reference channel	RESISTOR: .22 megohm ± 5%, 1/4 w	745 0183 00
R190	V119 plate decoupling	RESISTOR: .10 megohm ± 10%, 1/4 w	745 0170 00
R191	V120 Ref Amp cathode	RESISTOR: 680 ohm ± 10%, 1/2 w	745 1079 00
R192	Variable channel input	RESISTOR: .39 megohm ± 5%, 1/4 w	745 0194 00
R193	Variable channel filter input	RESISTOR: 330,000 ohm ± 1%, 0.1 w	721 0158 00
R194	Z103 filter phase shift control	RESISTOR: Variable wire-wound, 10,000 ohm ± 10%, 2 w	377 0111 00
R195	V121 cathode	RESISTOR: 1500 ohm ± 10%, 1/4 w	745 0093 00
R196	V121 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00
R197	V121 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00
R198	V121 plate supply decoupling	RESISTOR: .10 megohm ± 10%, 1/4 w	745 0170 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R199	V122 grid, voltage divider	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R200	V122 grid, voltage divider	RESISTOR: 39,000 ohm ± 5%, 1/4 w	745 0152 00
R201	V122 grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R202	V122 cathode	RESISTOR: 680 ohm ± 10%, 1/2 w	745 1079 00
R203	Tracking	RESISTOR: variable, 25,000 ohm ± 20%, 1 w	376 0055 00
R204	V123 cathode	RESISTOR: 3300 ohm ± 10%, 1/4 w	745 0107 00
R205	V123 OBI amp feedback	RESISTOR: .68 megohm ± 10%, 1/4 w	745 0205 00
R206	V123 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00
R207	V123 grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R208	V123 cathode	RESISTOR: 3300 ohm ± 10%, 1/4 w	745 0107 00
R209	V123 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00
R210	V123 plate decoupling	RESISTOR: .10 megohm ± 10%, 1/4 w	745 0170 00
R211	Frequency compensation	RESISTOR: .22 megohm ± 5%, 1/4 w	745 0183 00
R212		RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R213	30 cycle mixing cathode of V124 voltage divider	RESISTOR: 1500 ohm ± 10%, 1/4 w	745 0093 00
R214	30 cycle mixing cathode of V124 voltage divider	RESISTOR: 2200 ohm ± 10%, 1/4 w	745 0100 00
R215	V124 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R216	V124 plate coupling	RESISTOR: .22 megohm ± 10%, 1/4 w	745 0184 00
R217	V125 grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R218	V125 grid	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R219	OBI balance adjustment	RESISTOR: variable, 1000 ohm ± 20%, 1 w	376 0051 00
R220	V125 bias	RESISTOR: 22,000 ohm ± 10%, 1/4 w	745 0142 00
*R221	V125 bias adjusted for 1 ma./section	RESISTOR:	
R222	Voltage divider	RESISTOR: 160 ohm ± 5%, 10 w	710 0196 00
R223	Voltage divider	RESISTOR: 22 ohm ± 10%, 2 w	745 9027 00
R224	TO-FROM load	RESISTOR: 5600 ohm ± 10%, 1/4 w	745 0118 00
R225	TO-FROM load	RESISTOR: 5600 ohm ± 10%, 1/4 w	745 0118 00
R226	TO-FROM phase splitting	RESISTOR: 12,000 ohm ± 10%, 1/4 w	745 0132 00
R227	Current Stabilizer	RESISTOR: wire-wound, 470 ohm ± 5%, 1/2 w	707 0217 00
R228	Current Stabilizer	RESISTOR: wire-wound, 470 ohm ± 5%, 1/2 w	707 0217 00
R229		Not used	
R230		Not used	
R231	Flagalarm voltage dropping	RESISTOR: 27 ohm ± 5%, 1/2 w	745 1019 00
R232	Flagalarm voltage dropping	RESISTOR: 270 ohm ± 10%, 1/4 w	745 0062 00
R233	E102 bridge load	RESISTOR: wire-wound, 470 ohm ± 5%, 1/2 w	707 0217 00
R234	Metering circuit balance	RESISTOR: variable, 100 ohm ± 10%, linear, 2 w	377 0104 00

* Values chosen to fulfill requirements of individual receiver.

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R235	E102 bridge load	RESISTOR: wire-wound, 470 ohm ± 5%, 1/2 w	707 0217 00
R236	Localizer centering control	RESISTOR: variable, 15,000 ohm, linear, 4 w, .016 amp	377 0041 00
R237		Not used	
R238	Deviation indicator sensitivity control	RESISTOR: variable, 10,000 ohm ± 20%, 1 w	376 0054 00
R239	VOR sensitivity control	RESISTOR: variable, 1000 ohm ± 20%, 1 w	376 0051 00
R240	V126 plate	RESISTOR: 12,000 ohm ± 10%, 2 w	745 9143 00
R241	V126 grid	RESISTOR: 1.5 megohm ± 10%, 1/4 w	745 0219 00
R242	V126 cathode	RESISTOR: 1000 ohm ± 10%, 1/4 w	745 0086 00
R243	V121 AVC decoupling filter	RESISTOR: .33 megohm ± 10%, 1/4 w	745 0191 00
R244	V124 grid network	RESISTOR: .47 megohm ± 10%, 1/4 w	745 0198 00
R245	Tone localizer sensitivity control	RESISTOR: .10 megohm ±20%, 1 w	376 0057 00
R246	Swamping for Z103	RESISTOR: 56,000 ohm ± 10%, 1/4 w	745 0160 00
R247		RESISTOR: Not used	
R248	Filament dropping	RESISTOR: wire-wound, 0.63 ohm ± 10%, 5 w	747 9023 00
R249	Filament dropping	RESISTOR: wire-wound, 0.63 ohm ± 10%, 5 w	747 9023 00
R250	Limiter for R-245	RESISTOR: 33,000 ohm ±10%, 1/2 w	745 1149 00
R251		RESISTOR: Not used	
R252		RESISTOR: Not used	
R253		RESISTOR: Not used	

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R254		RESISTOR: Not used	
R255		RESISTOR: Not used	
R256		RESISTOR: Not used	
S101	Coarse frequency positioner	SWITCH: rotary, 20 position	269 1079 00
S102	Ccarse frequency positioner	SWITCH: rotary, 20 position	269 1081 00
S103	Coarse frequency positioner	SWITCH: rotary, 20 position	269 1080 00
S104	Fine frequency positioner	SWITCH: rotary, 20 position	269 1083 00
S105	Fine frequency positioner	SWITCH: rotary, 20 position	269 1082 00
S106	Coarse frequency crystal selector	SWITCH: rotary, 20 position	269 1084 00
S107	Fine Frequency crystal selector	SWITCH: rotary, 20 position	269 1085 00
T101	Antenna coil	COIL ASSEM, Antenna: 108-139.5 mc	504 2847 001
T102	1st mixer	COIL ASSEM, Mixer: 108-135.9 mc	520 3814 00
T103	Variable frequency I.F. Amp.	COIL ASSEM: 19.5-21.4 mc	503 7623 003
T104	2nd Mixer	COIL ASSEM: 19.5-21.4 mc	503 7624 003
T105	1st fixed I.F. Amp.	COIL ASSEM, I.F. Transformer: 3.2 mc	503 7625 003
T106	2nd fixed I.F. Amp.	COIL ASSEM, I.F. transformer: 3.2 mc	503 7625 003
T107	3rd fixed I.F. Amp.	COIL ASSEM, I.F. transformer: 3.2 mc	503 7625 003
T108	Fixed frequency I.F. output	COIL ASSEM, I.F. transformer: 3.2 mc	503 7625 003

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
T109	Audio Output	TRANSFORMER, AF: 300-3000 cps; pri: 20,000 ohm, 1000 TV, sec: 500 ohm, 1000 TV	677 0198 00
T110	LF injection Oscillator plate	COIL ASSEM: 16.3-18.2 mc	503 7607 00
T111	HF injection multiplier plate	COIL ASSEM, HFO amplifier: 88.5-114.5 mc	520 3816 00
T112	HF injection Oscillator plate	COIL ASSEM, HFO mixer: 29.5-38.16 mc	520 3815 00
T113	Disc. amp. output	TRANSFORMER: special, turns ratio pri to 1/2 of sec 1, 1:1, 1/2 of sec 1 to sec 2; 4:1 plus 158 mh ±15 choke	677 0197 00
T114	V120 push pull grid input	TRANSFORMER: audio input, single frequency 30 cps; pri: 330 ohm +20%; sec #1: 7500 ohm ±25%; sec #2: 7500 ohm ±25%	677 0203 00
T115	Reference amplifier output	TRANSFORMER: Audio output; single frequency 30 cps; pri: 25,000 ohm plate to plate load ±15%, 72 vac; sec #1: 190 ohm, d.c., 8.5 vac; sec #2: 200 ohm, d.c., 1000 TV, 8.5 vac; sec #3: 660 ohm d.c., 8.5 vac, CT	677 0199 00
T116	Variable phase channel, meter circuit output	TRANSFORMER: Audio output; single frequency 30 cps; pri: 25,000 ohm plate to plate load ±15%, 72 vac; sec #1: 190 ohm, d.c., 8.5 vac; sec #2: 200 ohm, d.c., 1000 TV, 8.5 vac; sec #3: 660 ohm d.c., 8.5 vac, CT	677 0199 00
T117	V124, OBI phase detector grid input	TRANSFORMER: Audio input, single frequency 30 cps; pri: 330 ohm ±20%; sec #1: 7500 ohm ±25%; sec #2: 7500 ohm ±25%	677 0203 00
T118	OBI output	TRANSFORMER: saturable reactor, inductance at 5 v, 400 cps: 44 mh +40 -10% at 1 ma dc; max current in DC winding 8 ma; max current in AC winding 110 ma	678 0204 00
TB101		TERMINAL BOARD ASSEMBLY: 16 terminal	504 2839 001

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
V101	RF amplifier	TUBE: Type 5654/6AK5; pentode	253 0001 00
V102	1st mixer	TUBE: Type 5654/6AK5; pentode	253 0001 00
V103	Variable Frequency IF Amp.	TUBE: Type 5654/6AK5; pentode	253 0001 00
V104	2nd mixer	TUBE: Type 5654/6AK5; pentode	253 0001 00
V105	1st fixed IF amp.	TUBE: Type 5654/6AK5; pentode	253 0001 00
V106	2nd fixed IF amp.	TUBE: Type 5654/6AK5; pentode	253 0001 00
V107	3rd fixed IF amp.	TUBE: Type 5654/ 6AK5; pentode	253 0001 00
V108	Detector	TUBE: Type 5726/6AL5; double diode	253 0003 00
V109	Noise limiter and Audio Amplifier	TUBE: Type 5751/12AX7; double triode	253 0012 00
V110	Audio Output and squelch	TUBE: Type 5814/12AU7; double triode	253 0013 00
V111	HF injection multiplier	TUBE: Type 5654/6AK5; pentode	253 0001 00
V112	HF injection osc.	TUBE: Type 5654/6AK5; pentode	253 0001 00
V113	LF injection osc.	TUBE: Type 5654/6AK5; pentode	253 0001 00
V114	RF screen voltage regulator	TUBE: Type 5751/12AX7; double triode	253 0012 00
V115	1/2 Reference Amplifier 1/2 OBS Resolver Amplifier	TUBE: Type 5814/12AU7; double triode	253 0013 00
V116	1st reference channel limiter	TUBE: Type 5751/12AX7; double triode	257 0052 00
V117	2nd reference channel limiter	TUBE: Type 5751/12AX7; double triode	253 0012 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
V118	1/2 OBI resolver amplifier 1/2 Discrimmator Amplifier	TUBE: Type 5814/12AU7; double triode	253 0013 00
V119	Reference Amplifier	TUBE: Type 5814/12AU7; double triode	253 0013 00
V120	Reference Amplifier	TUBE: Type 5814/12AU7; double triode	253 0013 00
V121	Variable phase amplifier	TUBE: Type 5814/12AU7; double triode	253 0013 00
V122	Variable phase amplifier	TUBE: Type 5814/12AU7; double triode	253 0013 00
V123	OBI Amplifier	TUBE: Type 5814/12AU7; double triode	253 0013 00
V124	OBI Phase detector	TUBE: Type 5814/12AU7; double triode	253 0013 00
V125	OBI reactor control	TUBE: Type 5814/12AU7; double triode	253 0013 00
V126	OBI injection	TUBE: Type 5814/12AU7; double triode	253 0013 00
XI101/ XI102	Lamp mtg.	MOUNTING, lamp	504 4560 001
XV101, XV102, XV103, XV104, XV105, XV106, XV107, XV108	Socket for V101, V102, V103, V104, V105, V106, V107, V108	SOCKET, tube: 7 contact minature	220 1034 00
XV109, XV110	Socket for V109, V110	SOCKET, tube: 9 contact miniature	220 1062 00
XV111, XV112, XV113	Socket for V111, V112, V113	SOCKET, tube: 7 contact miniature	220 1034 00
XV114, XV115	Socket for V114, V115	SOCKET, tube: 9 contact miniature	220 1062 00
XV116	Socket for V116	SOCKET, tube: 7 contact miniature	220 1034 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
XV117, XV118, XV119, XV120, XV121, XV122, XV123, XV124 XV125 XV126	Socket for V117, V118, V119, V120, V121, V122, V123, V124, V125, V126	SOCKET, tube: 9 contact miniature	220 1062 00
XY101 thru XY114	Sockets for Y101 thru Y114	SOCKET BOARD ASSEM, crystal: coarse freq. oscillator	503 5102 002
XY115 thru XY134	Sockets for Y115 thru Y134	SOCKET BOARD ASSEM, crystal: fine freq. oscillator	503 5101 002
Y101	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7375 kc	291 5176 00
Y102	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7541.667 kc	291 5177 00
Y103	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7708.333 kc	291 5178 00
Y104	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 7875 kc	291 5179 00
Y105	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8041.667 kc	291 5180 00
Y106	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8208.333 kc	291 5181 00
Y107	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8375 kc	291 5182 00
Y108	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8541.667 kc	291 5183 00
Y109	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8708.333 kc	291 5184 00
Y110	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 8875 kc	291 5185 00
Y111	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9041.667 kc	291 5186 00
Y112	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9208.333 kc	291 5187 00
Y113	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9375 kc	291 5188 00
Y114	1st h-f osc.	CRYSTAL: Type CR-18/u; freq 9541.667 kc	291 5189 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
Y115	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8150 kc	291 5190 00
Y116	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8200 kc	291 5191 00
Y117	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8250 kc	291 5192 00
Y118	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8300 kc	291 5193 00
Y119	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8350 kc	291 5194 00
Y120	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8400 kc	291 5195 00
Y121	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8450 kc	291 5196 00
Y122	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8500 kc	291 5197 00
Y123	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8550 kc	291 5198 00
Y124	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8600 kc	291 5199 00
Y125	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8650 kc	291 5200 00
Y126	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 5800 kc	291 5210 00
Y127	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8750 kc	291 5202 00
Y128	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8800 kc	291 5203 00
Y129	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8850 kc	291 5204 00
Y130	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 5933.333 kc	291 5211 00
Y131	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 8950 kc	291 5206 00
Y132	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 9000 kc	291 5207 00
Y133	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 9050 kc	291 5208 00
Y134	2nd h-f osc.	CRYSTAL: Type CR-18/u; freq 9100 kc	291 5209 00
Z101	Audio filter	REACTOR, filter: high pass; 300 cps, 10 v rms output	673 0166 00
Z102	9960 band pass filter	FILTER: 166 mh ±5%, coil resistance 60 ohm	673 0169 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
Z103	Variable channel filter	REACTOR, filter: 858 hy ±1% at .2 volts rms, 60 cps	678 0303 00
Z104	Phase positioning and low pass filter	PARTS ASSEMBLY, phase: includes 4 resistors, 8 capacitors and terminal board	504 2895 003
Z105	90 cycle band pass filter	FILTER, band pass: 90 cps center frequency	673 0160 00
Z106	150 cycle band pass filter	FILTER, band pass: 150 cps center frequency	673 0161 00
		MOUNT: Vibration, basic assembly	503 5801 004
		MOUNT SET: Vibration, 40 lb load (qty 4)	200 0158 00
		CONNECTOR: female contact, 45 term; mtd on shock-mtg	370 2034 00
416N-1	POWER SUPPLY		
C301	High voltage filter	CAPACITOR, Paper: 3.9 mf ±3% at 60 cps, 330 WV ac at 60 cps	930 0096 00
C302	High voltage filter	CAPACITOR, Paper: 3.9 mf ±3% at 60 cps, 330 WV ac at 60 cps	930 0096 00
C303	High voltage noise filter	CAPACITOR, Paper: 0.1 mf ±20%, 600 WV	930 0029 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION		COLLINS PART NUMBER
C304	Low voltage noise filter	CAPACITOR, Paper: 1.3 mf ±20%, 50 WV		930 0004 00
C305	Primary noise filter	CAPACITOR, Mica: 10,000 mmf ±20%, 300 WV		JAN type # CM35A103M
C306	Secondary noise filter	CAPACITOR, Mica: 6200 mmf ± 5%, 500 WV		JAN type # CM35A622J
C307	High voltage filter	CAPACITOR, Paper: 3.9 mf ±6% at 60 cps, 330 WV ac at 60 cps		930 0095 00
C308	High voltage filter	CAPACITOR, Paper: 3.9 mf ±6% at 60 cps, 330 WV ac at 60 cps		930 0095 00
D301	Receiver power	DYNAMOTOR: Input: 26.5 v dc at 2.6 amp; output: 260 v dc at .135 amp; (includes C305 and C306 listed above)		231 0036 00
	Replaceable parts for D301	FIELD COIL (Set),	(1)	234 0172 00
		BRUSH HOLDERS (Input)	(2)	234 0173 00
		BRUSH ASSEMBLY (Input)	(2)	234 0174 00
		BRUSH HOLDER CAP	(4)	234 0175 00
		BRUSH HOLDER (Output)	(2)	234 0176 00
		BRUSH ASSEMBLY (Output)	(2)	234 0177 00
		ARMATURE ASSEMBLY, includes one armature, 2 grease slingers and 2 bearings	(1)	234 0178 00
		BEARING	(2)	234 0167 00
L301	High voltage filter	REACTOR, Filter: 3.62 hy ±5% at 1.3 v, 30 cps, 1600 rms TV		678 0210 00
L302	High voltage filter	REACTOR, Filter: 7.5 hy, 10 v, 60 cps; 1600 rms TV		678 0211 00
L303	High voltage noise filter	COIL, RF Choke: 1 mh ±10%, 300 ma		240 5800 00
L304	Primary power noise filter	COIL, RF Choke: .058 mh; powdered iron core		240 0048 00
P301	Power plug	CONNECTOR, Male Contact: 6 term, wall mtg		365 2060 00
P302	Mounting base power plug	CONNECTOR, Male Contact : 3 term, wall mtg		357 3012 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
X301	Mounting base power socket	CONNECTOR, Female contact: 6 term	366 2060 00
314U-5	6 CONTROL UNIT		
I401		LAMP, instrument: 3 v, 0.19 amp; special screw base	262 0064 00
S401A		SWITCH, rotary: 14 position; bakelite	269 1073 00
S401B		SWITCH, rotary: 14 position; bakelite	269 1074 00
S401C		SWITCH, rotary: 14 position; bakelite	269 1075 00
S401D		SWITCH, rotary: 50 position; bakelite	269 1076 00
S401E		SWITCH, rotary: 20 position; bakelite	269 1263 00
S401F		SWITCH, rotary: 20 position; bakelite	269 1262 00
S402		SWITCH, toggle: SPST; 3 amp, 250 v	260 0833 00
351A-1	ACCESSORY UNIT		
	Filter (qty 4)	CAPACITOR, Paper: 3.9 mf ±6% at 60 cps; 330 WV ac, 60 cps	930 0095 00
J501		CONNECTOR: Female contact: 45 term	370 2034 00
P501	Omni-bearing connector (#1)	CONNECTOR, female contact: 17 term; wall mtg; shell size 20	357 9023 00
P502	Omni-bearing connector (#2)	CONNECTOR, female contact: 17 term; wall mtg; shell size 20	357 9023 00
P503	Servo amplifier connector (pilot)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P504	Servo amplifier connector (co-pilot)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P505	Servo amplifier connector (navigator)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
P506	Power supply connector (#1)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P507	Power supply connector (#2)	CONNECTOR, female contact: 6 term; wall mtg	366 2060 00
P508	Rear connector	CONNECTOR, male contact: 45 term; wall mtg	370 2033 00
	Accessory unit shock mount assembly	MOUNT, vibration: Basic assembly	503 5801 004
	Rubber mounting feet	MOUNT SET, vibration: 40 lb. load (qty 4)	200 0158 00
333B-1/3 Servo Amplifier			
C601	Cathode bypass	CAPACITOR, Paper: .2 mf ±20%, 120 WV	931 0151 00
C602	Cathode bypass	CAPACITOR, Paper: .2 mf ±20%, 120 WV	931 0151 00
C603	Output filter	CAPACITOR, Paper: Dual sect; .1/.1 mf +40 -15%, 600 WV	961 5038 00
C604	Output filter	CAPACITOR, Paper: Dual sect; .1/.1 mf +40 -15%, 600 WV	961 5038 00
C605	Output filter	CAPACITOR, Paper: 2 mf -20 +30%, 100 WV	931 0039 00
*E601	333B-3 Connector strip	STRIP: 6 term, bakelite	367 0121 00
*J601	333B-3 connector plug receptacle	CONNECTOR: 6 prong chassis mtg	366 2060 00
P601	Power plug	CONNECTOR, Male Contact: 6 term chassis mtg	365 2060 00
R601	Input resistance	RESISTOR: 470 ohm ±20%, 1/2 w	745 1073 00
R602	V601 grid 7 return	RESISTOR: 270,000 ohm ±10%, 1/4 w	745 0188 00
R603	V601 grid 3 return	RESISTOR: 270,000 ohm ±10%, 1/4 w	745 0188 00
R604	V601 cathode 2	RESISTOR: 2700 ohm ±10%, 1/4 w	745 0104 00

* Use with 333B-3 only

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R605	V601 cathode 8	RESISTOR: 2700 ohm ±10%, 1/4 w	745 0104 00
R606	V601 Common cathode	RESISTOR: 1500 ohm ±10%, 1/4 w	745 0093 00
T601	Amplifier input	TRANSFORMER, Input: Turns ratio 1:20; Pri reactance greater than 1000 ohms at 0.25 v rms 400 cps; Pri input 0-5 v, 400 cps	677 0220 00
T602	Amplifier output	REACTOR, Saturable: DC winding: 4750 ohms ±20%; 8 ma max: AC winding: 7.5 ohm ±10%; 110 ma max; 500 TV rms	678 0204 00
T603	Auto-transformer	TRANSFORMER, auto: 400 cps; 150 v, 10 ma/115 v, 100 ma/26.5 v; 230 ma/ 6.3 v, 350 ma; 2500 TV	672 0221 00
V601	Amplifier	TUBE, Electron: Type 2C51, dual triode	253 0002 00
XV601	Socket for V601	SOCKET, Tube: miniature, 9 term, phenolic	220 1051 00
336A-2	OMNI-BEARING SELECTOR		
B701	Resolver	AUTOSYN RESOLVER: 2 phase stator for 30 cyc; single phase rotor; voltage ratio: pri excited with 1 v, 30 cps, sec 0.465 v ±10% max	230 0077 00
I701	Dial lamp	LAMP, Instrument: 3 v, 0.19 amp; special screw base	262 0064 00
M701	Indicator	METER: 250-0-250 microamperes DC; perm magnet movable coil	458 0112 00
P701	Connector	CONNECTOR, Male Contact: 10 term; wall mtg; shell size 18	357 3006 00
S701	Switch	SWITCH: Consists of:	
		SEGMENT: 2 stator contacts (qty 2)	503 7161 001
		CONTACT: Right	503 5342 001
		CONTACT: Left	503 5343 001
X1701		MOUNTING: Pilot light	503 5291 001

ITEM	CIRCUIT FUNCTION	DESCRIPTION		COLLINS PART NUMBER
416N-2 POWER SUPPLY				
C801	H-V filter	CAPACITOR: Paper, 3.9 mf ±3%, 330 WV		930 0096 00
C802	H-V filter	CAPACITOR: Paper, 3.9 mf ±3%, 330 WV		930 0096 00
C803	H-V filter	CAPACITOR: Paper, 0.1 mf ±20%, 600 WV		930 0029 00
C804	Dynamotor input filter	CAPACITOR: Paper 1.3 mf ±20%, 50 WV		930 0004 00
C805	Dynamotor input filter	CAPACITOR: Paper, 1.3 mf ±20%, 50 WV		930 0004 00
C806	H-V filter	CAPACITOR: Paper, 3.9 mf ±6%, 330 WV		930 0095 00
C807	H-V filter	CAPACITOR: Paper, 3.9 mf ±6%, 330 WV		930 0095 00
C808	Dynamotor input filter	CAPACITOR: Mica, 10,000 mmf ±20%, 300 WV		JAN type # CM35A103M
C809	Dynamotor input filter	CAPACITOR: Mica, 10,000 mmf ±20%, 300 WV		JAN type # CM354103M
C810	Dynamotor output filter	CAPACITOR: Mica, 6200 mmf ±5%, 500 WV		JAN type # CM35A622J
D801	H-V power	DYNAMOTOR: Dual input voltage, 13.25v DC or 26.5 v DC nom; output 260 v DC +3% -5% at 135 ma +26.5 v with 13.25 v input (includes C808, C809, C810 listed above		231 0037 00
	Replaceable parts for D801	FIELD COIL (Set)	(1)	234 0157 00
		BRUSH HOLDER (Input)	(2)	234 0158 00
		BRUSH ASSEMBLY (Input)	(2)	234 0159 00
		BRUSH HOLDER CAP (Input)	(2)	234 0160 00
		BRUSH HOLDER (Output)	(4)	234 0161 00
		BRUSH ASSEMBLY (Output)	(2)	234 0162 00
		BRUSH ASSEMBLY (Output)	(2)	234 0163 00
		BRUSH HOLDER CAP	(2)	234 0164 00
		BRUSH HOLDER CAP	(2)	234 0165 00
		Armature Assembly, includes one armature, 2 grease slingers, and 2 bearings	(1)	234 0166 00
		BEARING	(2)	234 0167 00

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
E801	Dynamotor	STRIP: 4 terminal connectors	367 0002 00
L801	H-V filter	REACTOR: Filter, 3.62 hy ±5% at 1.3 v 30 cps, 1600 rms TV	678 0210 00
L802	H-V filter	REACTOR: Filter, 7.5 hy, 10 v, 60 cps 1600 rms TV	678 0211 00
L803	H-V filter	COIL: RF choke, 1 mh ±10%, 300 ma	240 5800 00
L804	Dynamotor input filter	COIL: RF choke, .058 mh, powdered iron core	240 0048 00
L805	Dynamotor input filter	COIL: RF choke, 0.058 mh, powered iron core	240 0021 00
P801	Power unit input and output connector	CONNECTOR: 4 contact, pin insert	357 3013 00
337A-2	OMNI-BEARING INDICATOR		
B901	Control motor	MOTOR: 2 phase 400 cps, 18 v rms and 1.5 w per phase	230 0107 00
B902	Phase shifter	AUTOSYN RESOLVER: 2 phase stator for 30 cyc; single phase rotor; voltage ratio: pri exciter with 1 v, 30 cps, sec 0.465 v ±10% max	230 0077 00
B903	Differential	AUTOSYN DIFFERENTIAL: Y connected 3 phase rotor and stator; normal excitation output voltage from 26 v 400 cps single phase excited autosyn	230 0076 00
P901	Control wire connector	CONNECTOR: 17 contact plug, pin insert, box mtg.	357 3003 00

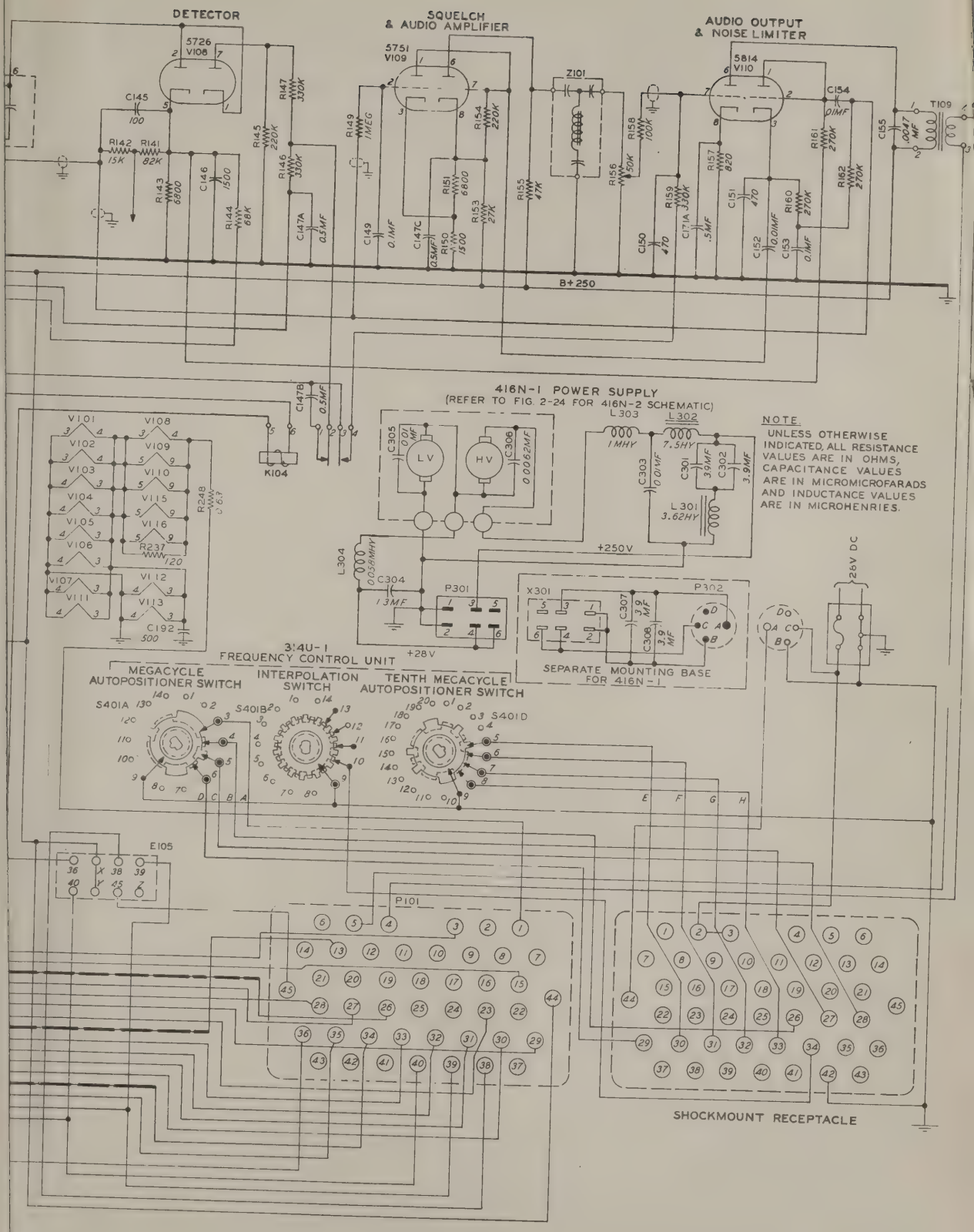


Figure 7-1 51R-2 Receiver Communication Circuits

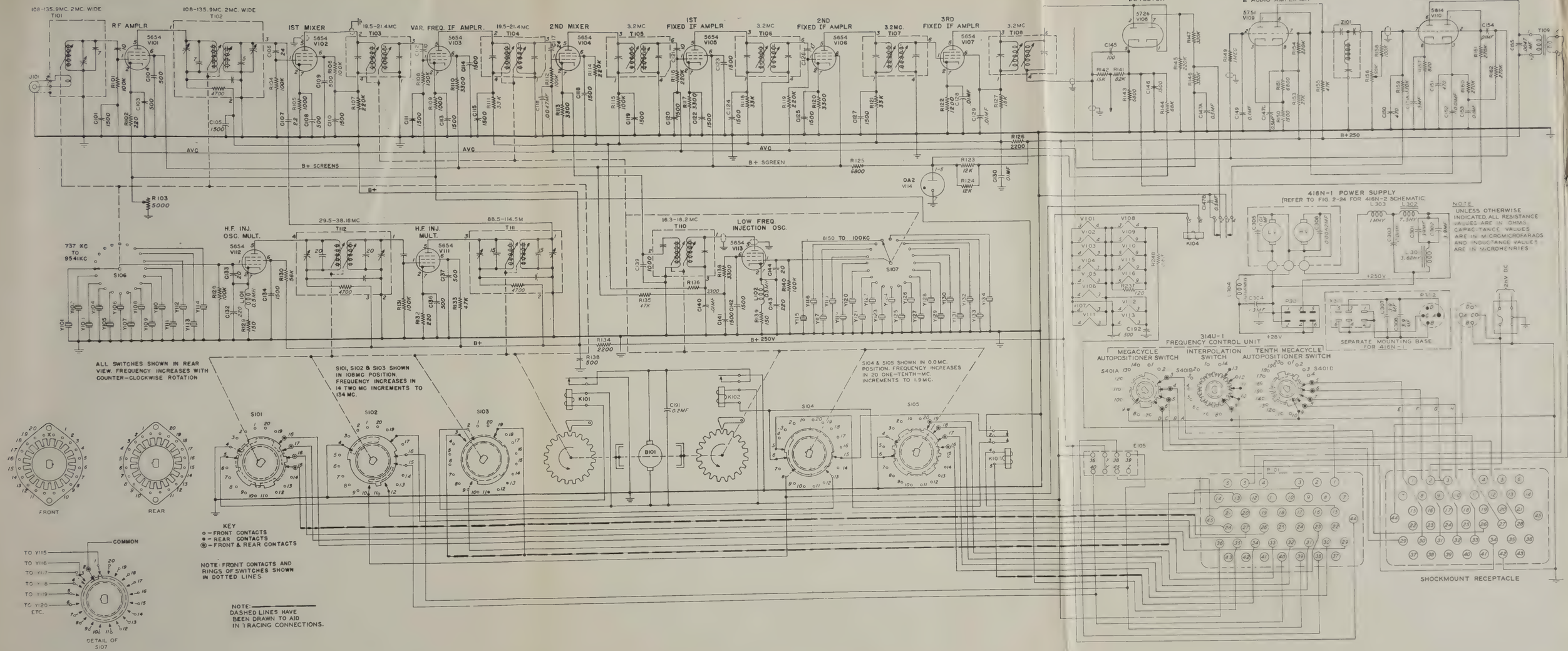


Figure 7-1 51R-2 Receiver Communication Circuits

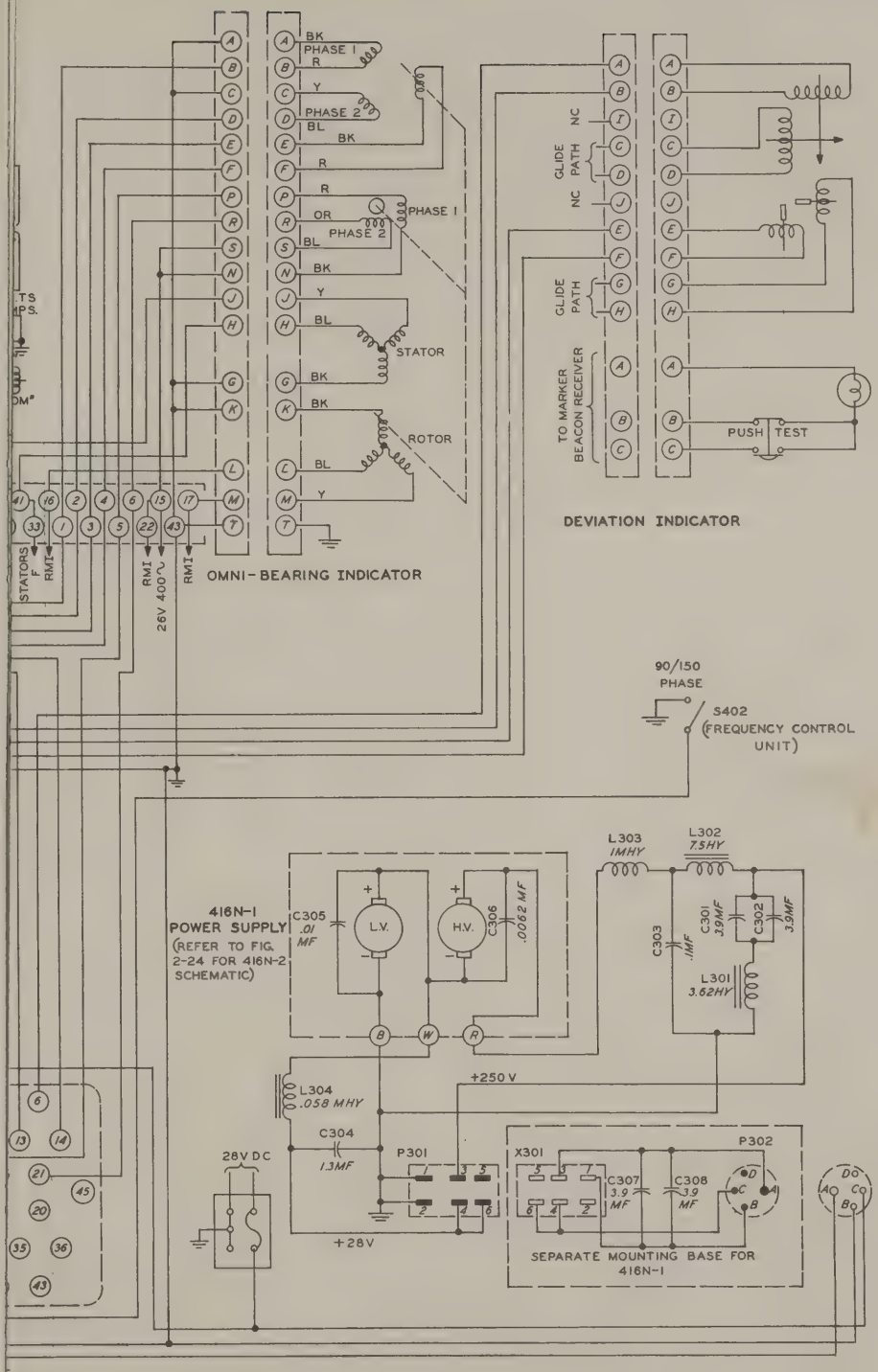


Figure 7-2 51R-2 Receiver Instrumentation Circuits

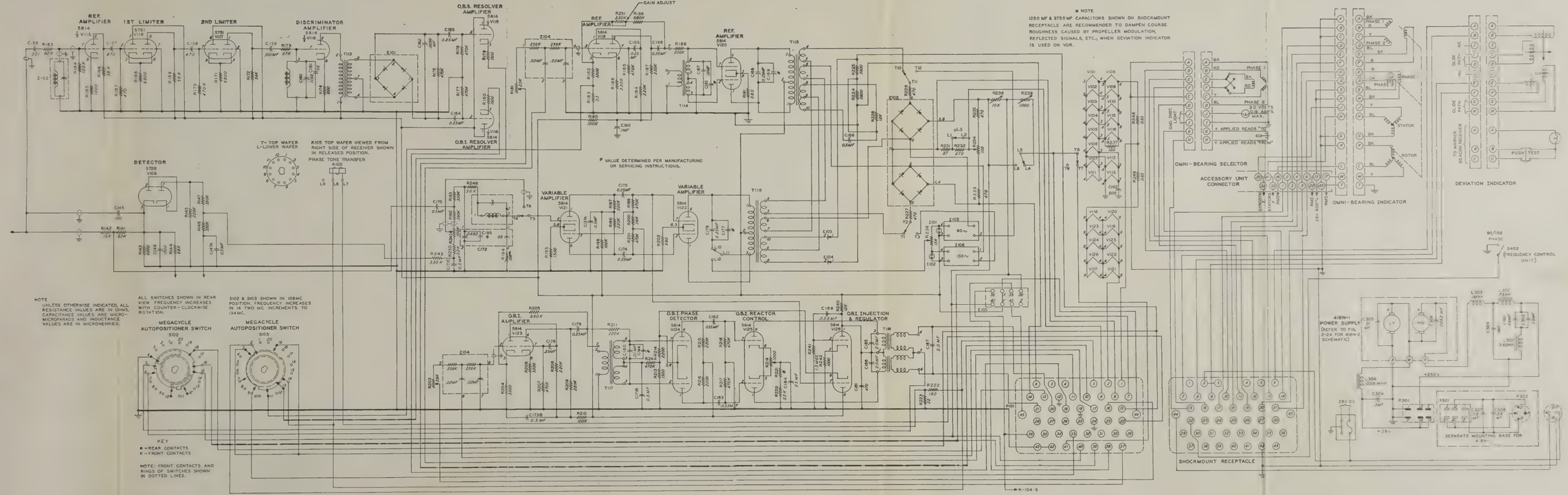

REF. AMPLIFIER 5814 V115
1ST LIMITER 5751 V116
2ND LIMITER 5751 V117
DISCRIMINATOR AMPLIFIER 5814 V118
G.B.S. RESOLVER AMPLIFIER 5814 V115
G.B.I. RESOLVER AMPLIFIER 5814 V118
GAIN ADJUST
REF. AMPLIFIER 5814 V119
REF. AMPLIFIER 5814 V120
DETECTOR 5726 V106
T- TOP WAFER L-LOWER WAFER
K105 TOP WAFER VIEWED FROM RIGHT SIDE OF RECEIVER SHOWN IN RELEASED POSITION.
PHASE TONE TRANSFER
VALUE DETERMINED PER MANUFACTURING OR SERVICING INSTRUCTIONS.
VARIABLE AMPLIFIER 5814 V121
VARIABLE AMPLIFIER 5814 V122
G.B.I. AMPLIFIER 5814 V123
G.B.I. PHASE DETECTOR 5814 V124
G.B.I. REACTOR CONTROL 5814 V125
G.B.I. INJECTION & REGULATOR 5814 V126
* NOTE
1250 MF & 3750 MF CAPACITORS SHOWN ON SHOCKMOUNT RECEPTACLE ARE RECOMMENDED TO DAMPEN COURSE ROUGHNESS CAUSED BY PROPELLER MODULATION, REFLECTED SIGNALS, ETC., WHEN DEVIATION INDICATOR IS USED ON VOR.
OMNI-BEARING SELECTOR
ACCESSORY UNIT CONNECTOR
OMNI-BEARING INDICATOR
DEVIATION INDICATOR
PHASE 1
PHASE 2
3.0 VOLTS V.R.B. AMPS MAX.
+ APPLIED READS "TO"
- APPLIED READS "FROM"
STATOR
ROTOR
TO MARKER BEACON RECEIVER
GLIDE PATH INC.
GLIDE PATH
PUSH TEST
90/150 PHASE
5402 (FREQUENCY CONTROL UNIT)
4(8N-1 POWER SUPPLY (REFER TO FIG. 2-24 FOR 4(8N-2 SCHEMATIC)
+250 V.
28V DC
+28V
SEPARATE MOUNTING BASE FOR 4 6N-
SHOCKMOUNT RECEPTACLE
NOTE
UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE MICRO-MICROFARADS AND INDUCTANCE VALUES ARE IN MICROHENRIES.
ALL SWITCHES SHOWN IN REAR VIEW FREQUENCY INCREASES WITH COUNTER-CLOCKWISE ROTATION.
S102 & S103 SHOWN IN 108MC POSITION. FREQUENCY INCREASES IN 14 TWO MC INCREMENTS TO 134 MC.
MEGACYCLE AUTOPOSITIONER SWITCH S102
MEGACYCLE AUTOPOSITIONER SWITCH S103
KEY
• - REAR CONTACTS
○ - FRONT CONTACTS
NOTE: FRONT CONTACTS AND RINGS OF SWITCHES SHOWN IN DOTTED LINES.
P101
J101
K-1045

Figure 7-2 51R-2 Receiver Instrumentation Circuits

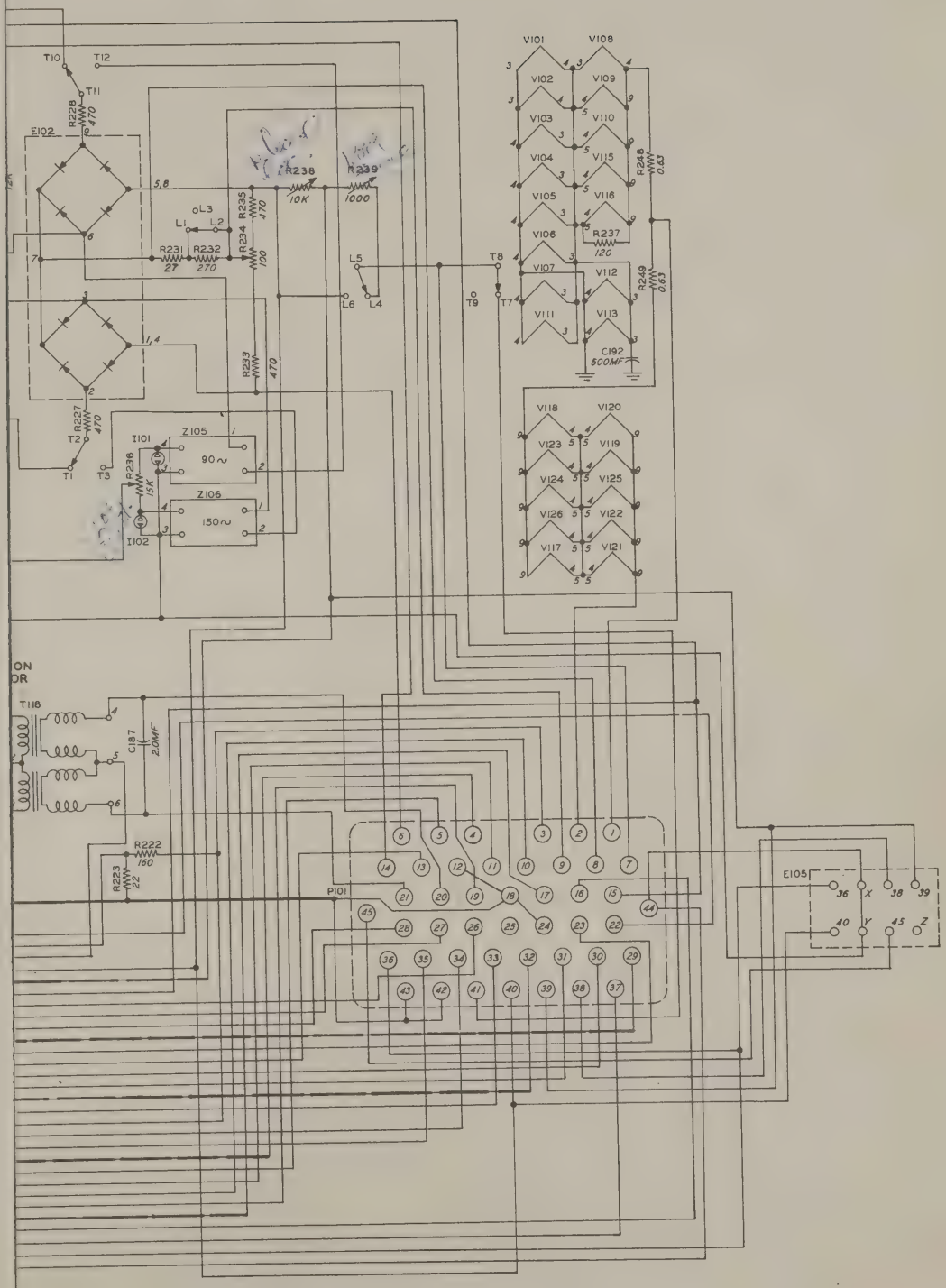


Figure 7-3 51R-2 Receiver Schematic

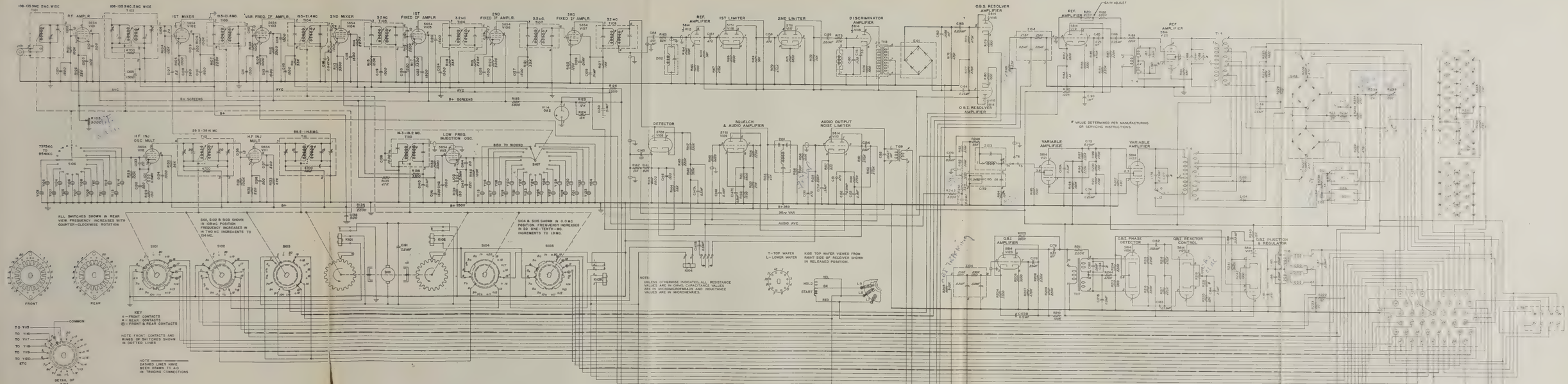


Figure 7-3 51R-2 Receiver Schematic

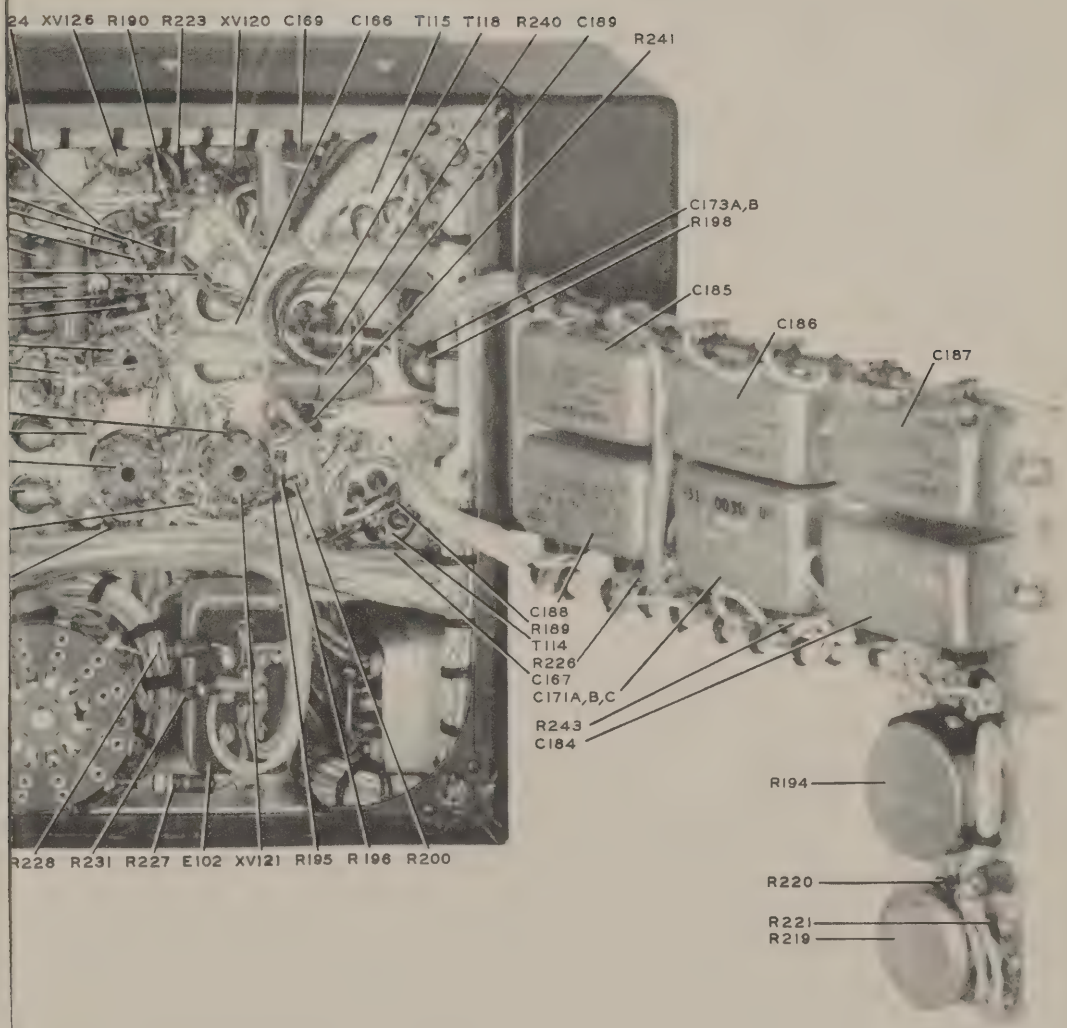


Figure 7-4 51R-2 VHF Navigation Receiver,Right Side

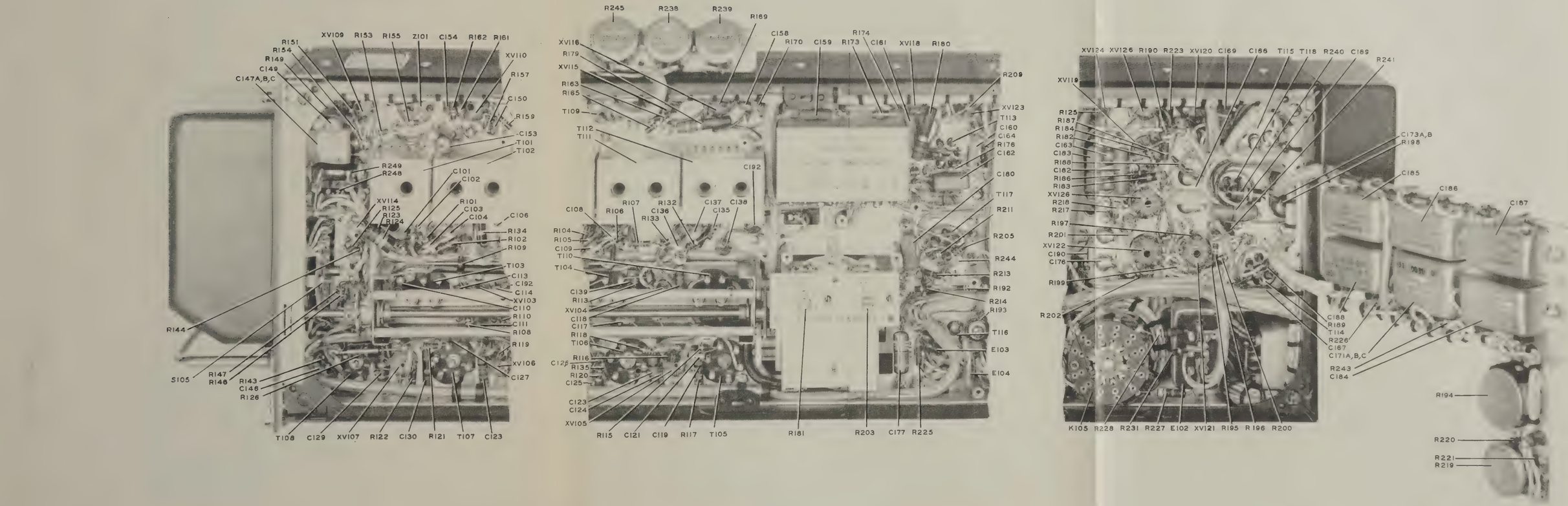


Figure 7-4 51R-2 VHF Navigation Receiver,Right Side

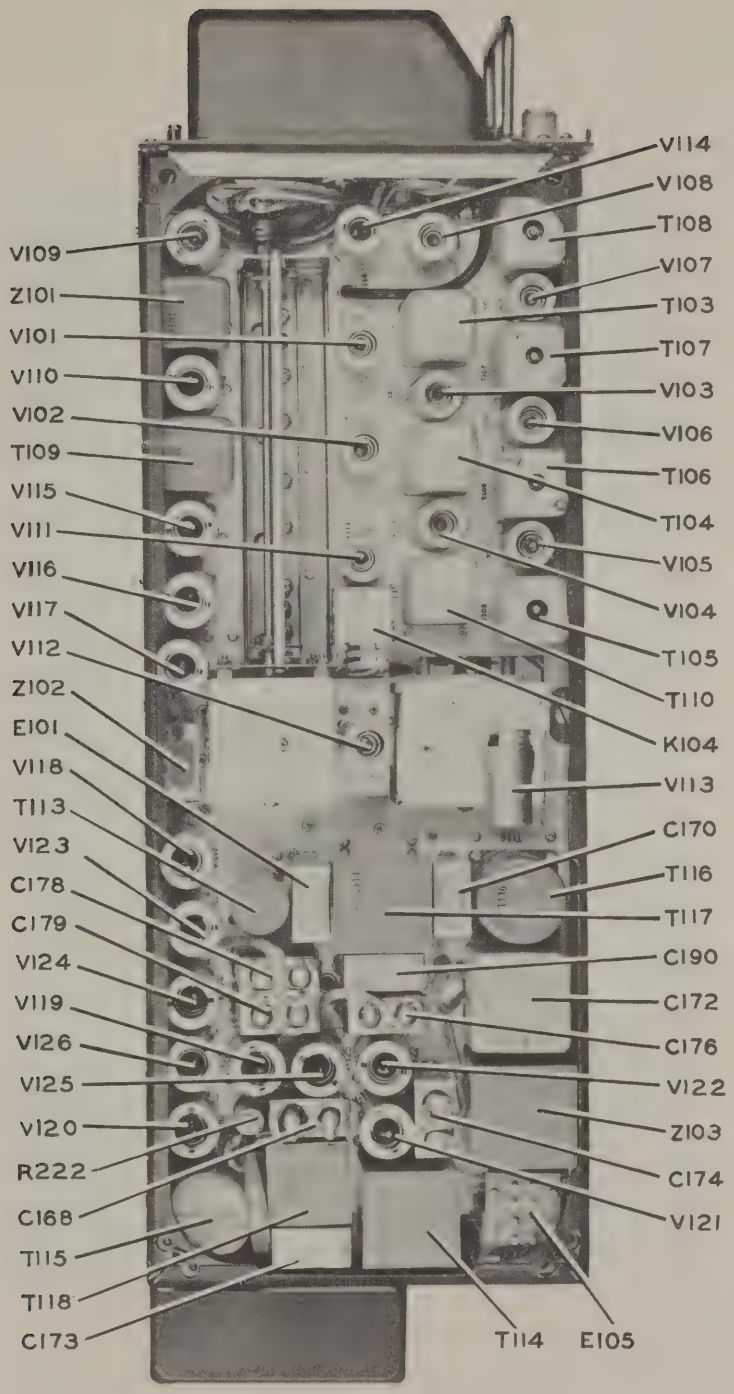


Figure 7-5 51R-2 VHF Navigation Receiver, Left Side

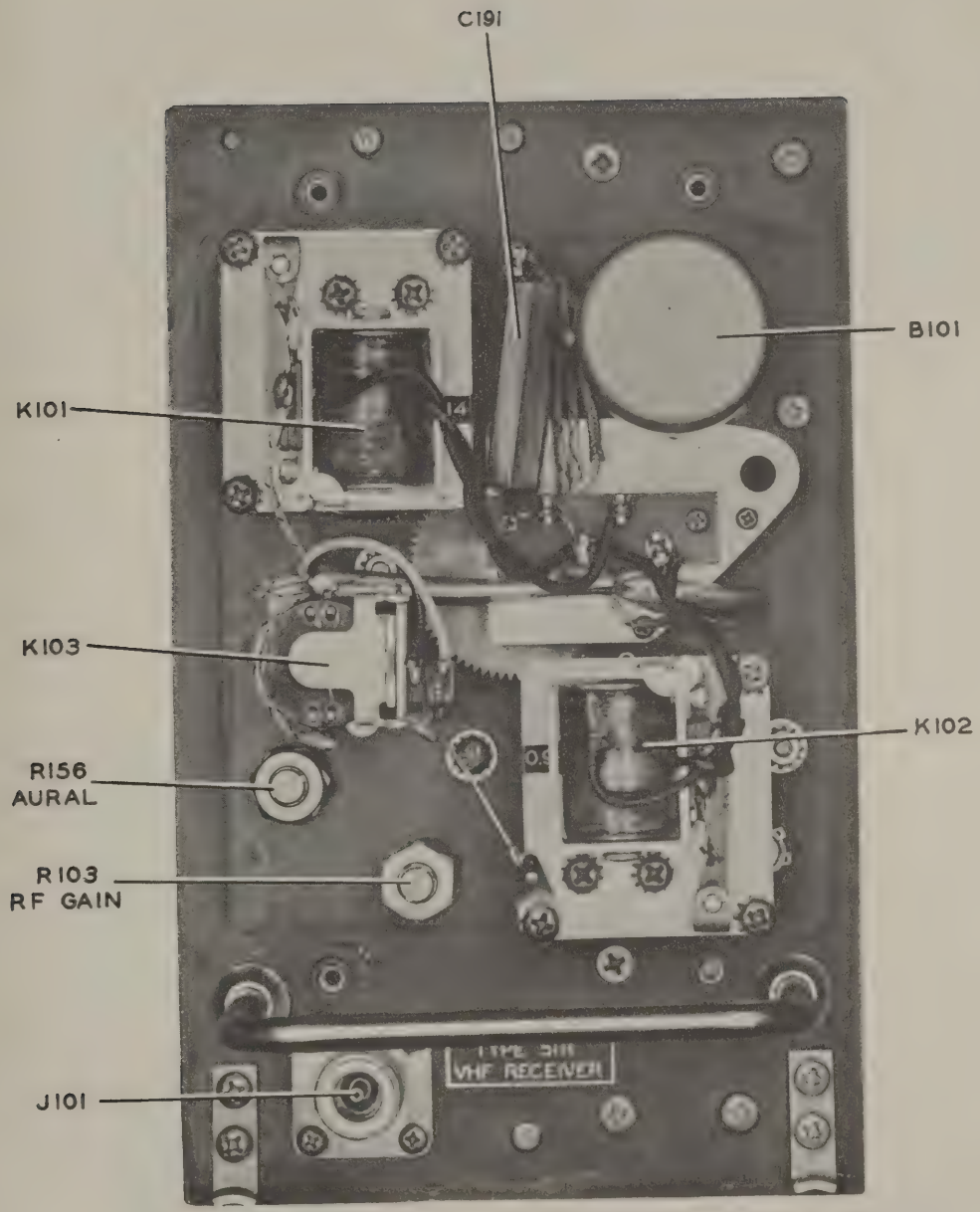


Figure 7-6 51R-2 Receiver, Front, Dust Cover Removed

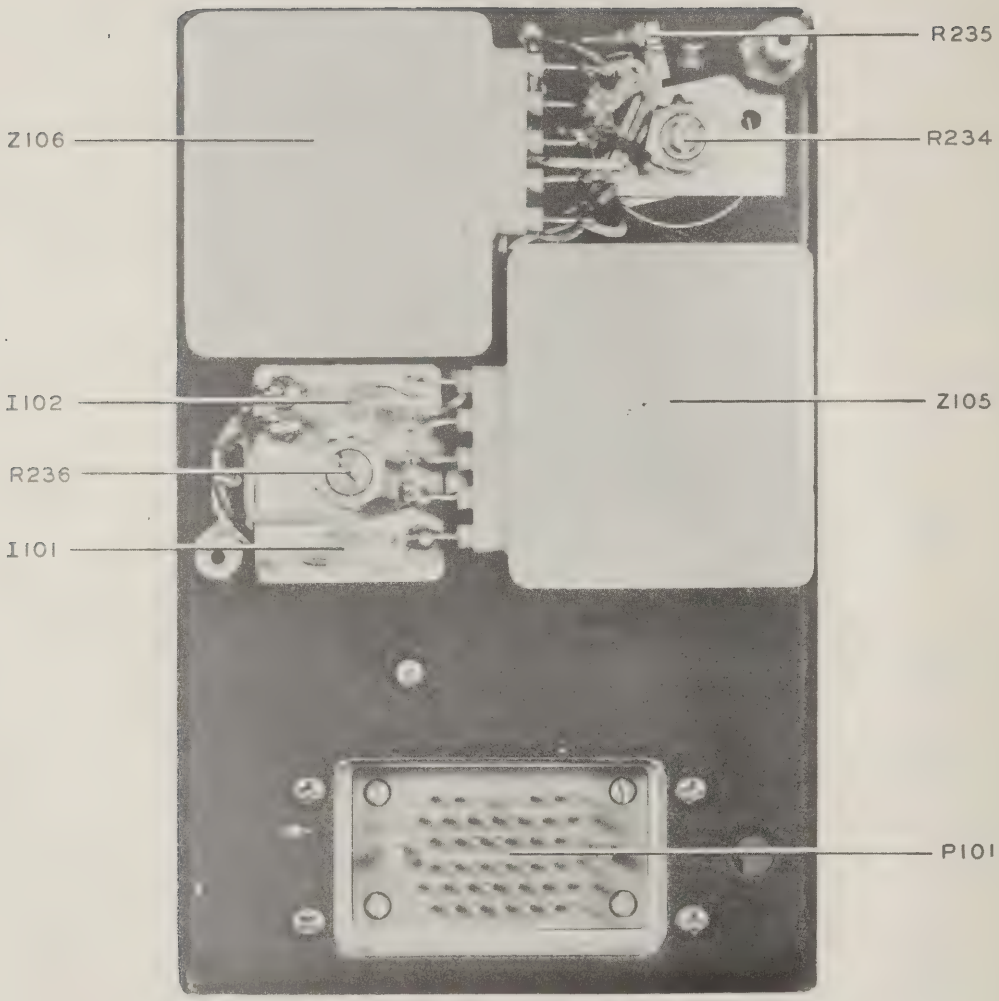


Figure 7-7 51R-2 Receiver, Rear, Dust Cover Removed

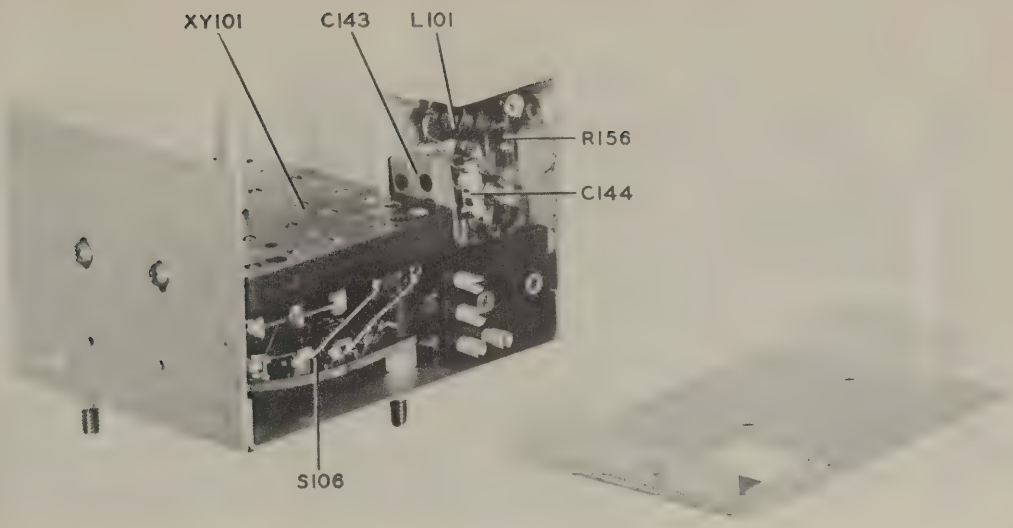


FIGURE 7-8 MEGACYCLE OSCILLATOR

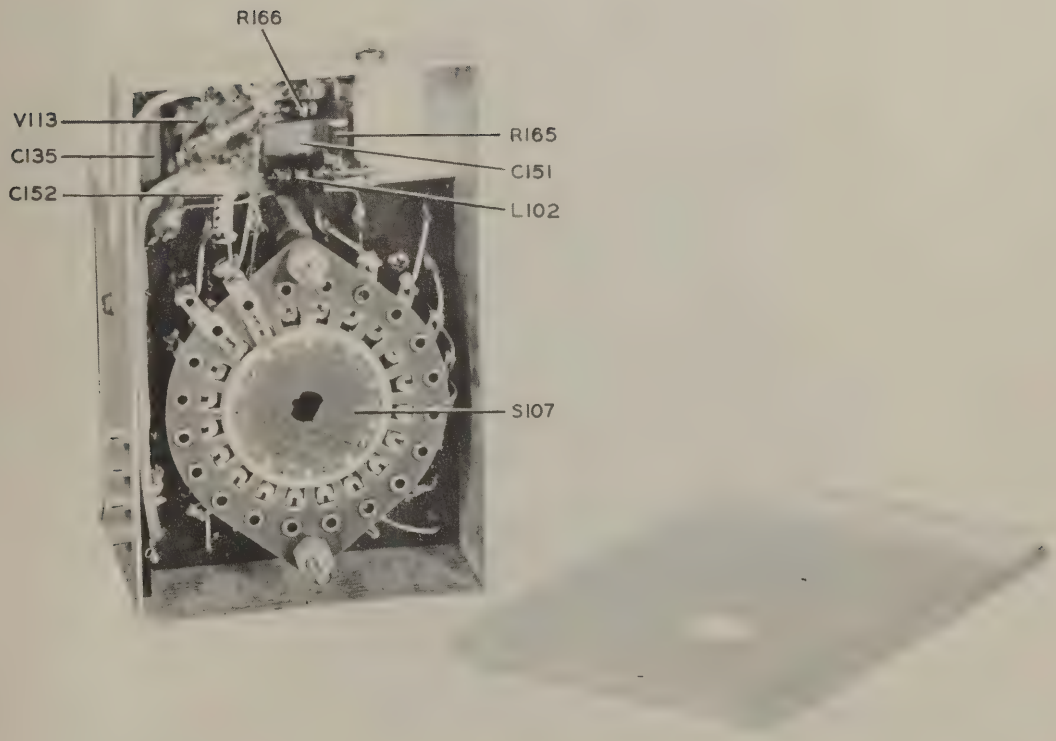


FIGURE 7-9 TENTH MEGACYCLE OSCILLATOR

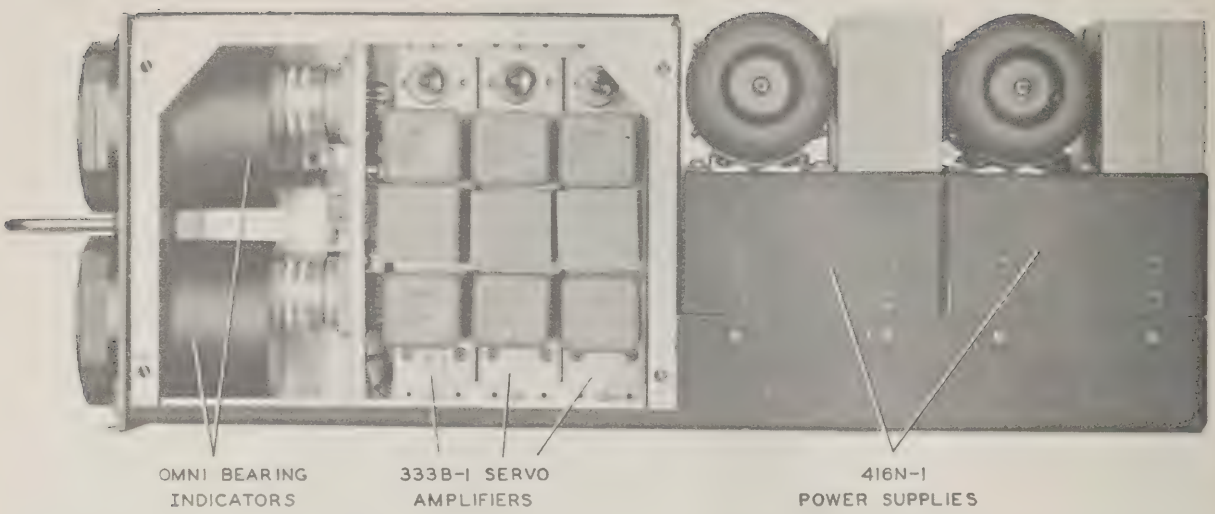


FIGURE 7-10 351A-1 ACCESSORY UNIT, SIDE OPEN

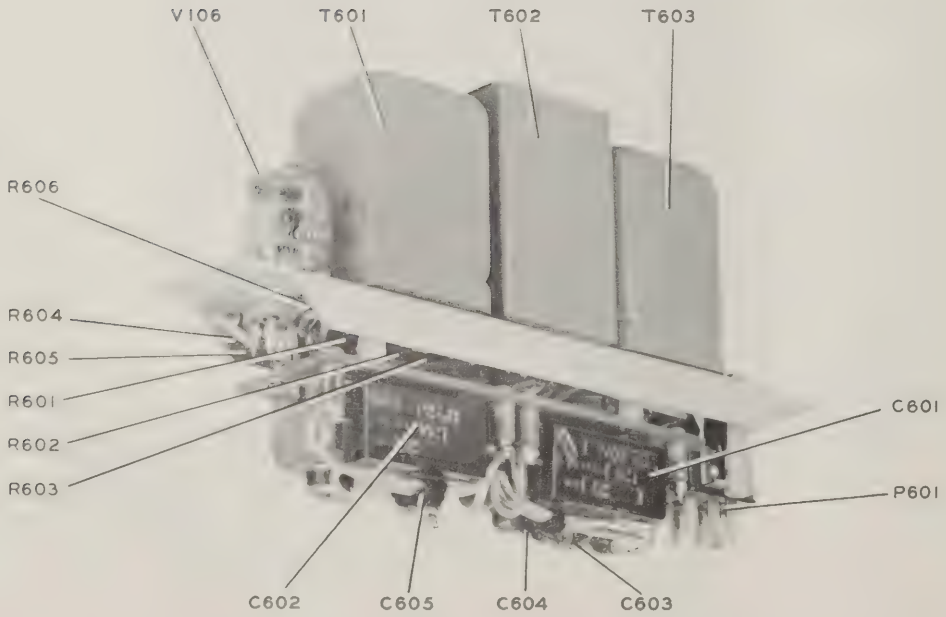
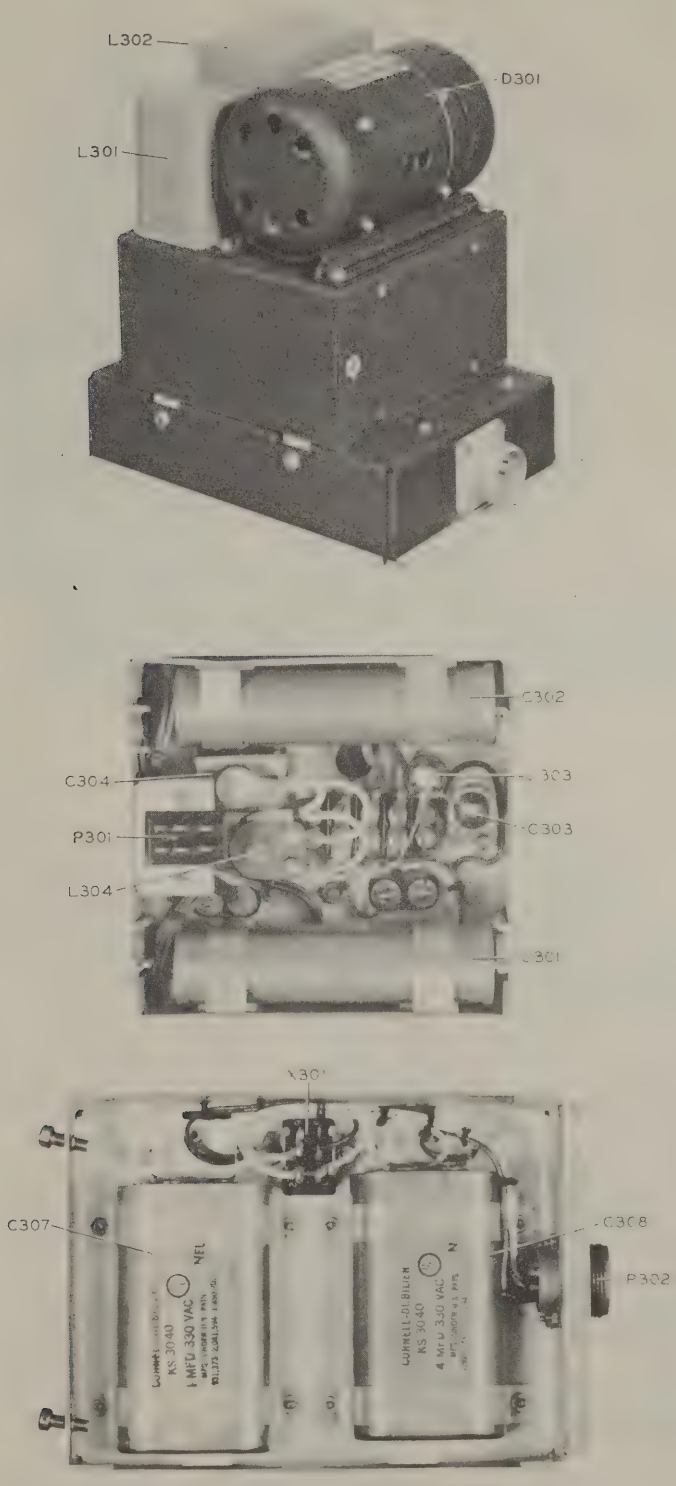


FIGURE 7-11 333B-1 SERVO AMPLIFIER, SIDE



NOTE: REFER TO FIGURE 2-6 FOR IDENTIFICATION OF THESE ASSEMBLIES.

FIGURE 7-12 416N-1 POWER UNIT

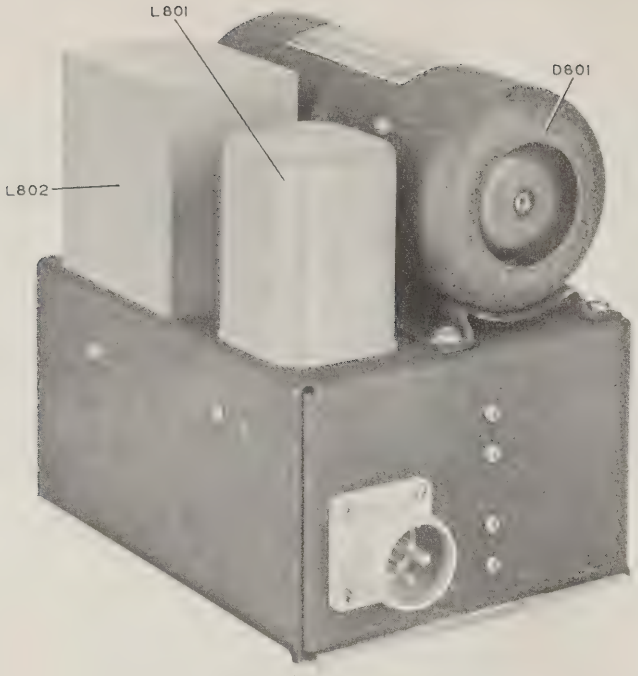


FIGURE 7-13 416N-2 POWER SUPPLY
OBLIQUE

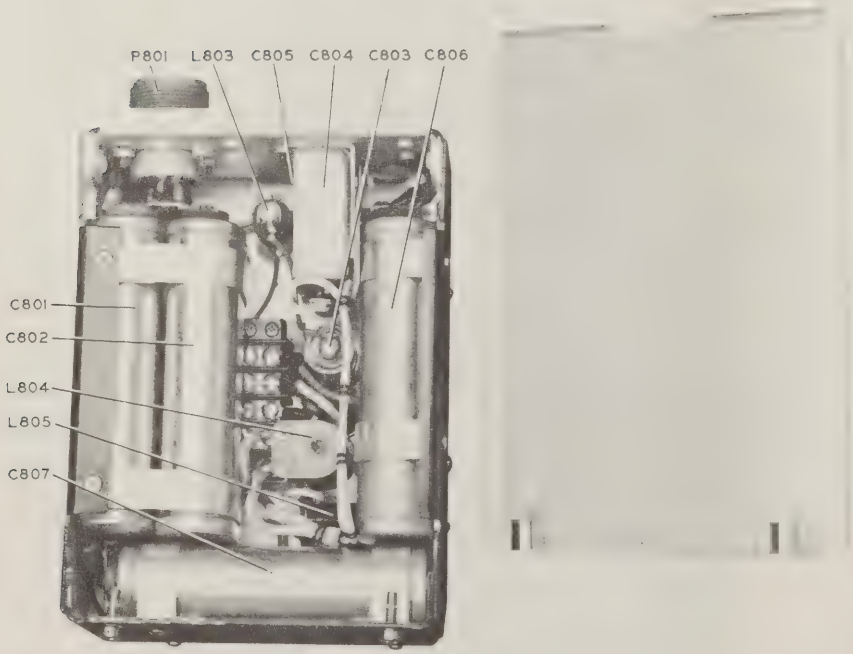


FIGURE 7-14 416N-2 POWER SUPPLY
BOTTOM OPEN

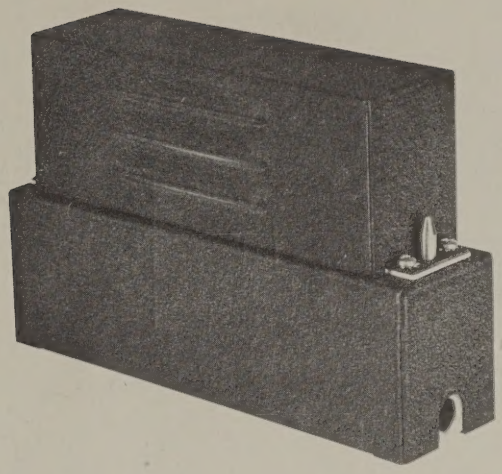
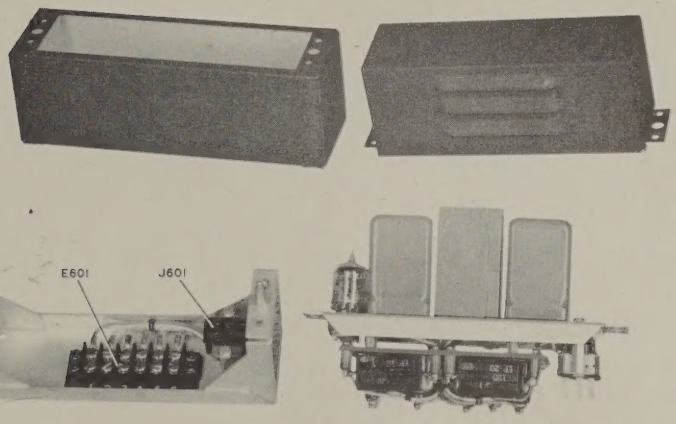


FIGURE 7-15 333B-3 SERVOAMPLIFIER
OBLIQUE



THIS AMPLIFIER SAME AS
333B-1

FIGURE 7-16 333B-3 SERVOAMPLIFIER
DISASSEMBLED

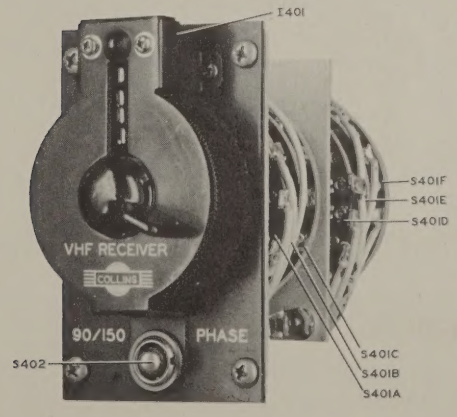


FIGURE 7-17 314U-1 FREQUENCY CONTROL UNIT